DOCUMENT RESUME

ED 237 195 PS 013 884

AUTHOR Nesdale, Andrew R., Ed.; And Others
TITLE Advances in Child Development: Theory and Research.
SPONS AGENCY University of Western Australia, Perth. Dept. of Education.
REPORT NO ISBN-0-9594161-0-2
PUB DATE 81
NOTE 277p.; Papers presented at the National Conference on Child Development (Perth, Australia, August 18-21, 1980).
PUB TYPE Collected Works - Conference Proceedings (021) -- Reports - Research/Technical (143) -- Books (010)

EDRS PRICE MF01/PC12 Plus Postage.
DESCRIPTORS Adolescents; *Child Development; *Cognitive Development; *Communication (Thought Transfer); Elementary School Students; Elementary Secondary Education; Foreign Countries; Infant Behavior; Infants; *Language Acquisition; Parents; *Perceptual Development; Preschool Children; Preschool Education; *Social Development
IDENTIFIERS *Australia; Piagetian Theory

ABSTRACT

This book consists of 31 papers focusing on aspects of child development. Mainly reports of research, papers are grouped topically into four sections dealing respectively with perceptual, language/communication, cognitive, and social development. Most of the nine papers in section 1 focus on the perceptual development of infants. Topics include visual perception of movement, object concept, Piagetian and Gibsonian theories, mismatched sensory information, looking and listening, bimodal perception, and manipulative skill. Also included are studies of contrast sensitivity among children and adolescents and investigations of touch and vision among preschool children. The eight papers in section 2 report on language and communication skills, mainly among preschool and elementary school children. Discussed are spatial/temporal relationships, reading strategies, dichotic listening, linguistic experience, word segmentation skills, racial and social class influences on verbal information seeking, visual language training, and classroom communication. Specific problems addressed include spelling difficulties, poor reading, delayed language, aphasia, and mental retardation. The seven articles in section 3 explore rationality, metacognition, memory, continuity/discontinuity in cognitive development, and eidetic imagery, as well as line and angle estimation by mentally retarded children and adolescents. The seven papers in section 4 include articles on current issues, parents' beliefs about cognitive development, children's concepts of death, prejudice in childhood, origins of the self, infant crying and maternal responsiveness, and description and explanation in studies of mother/infant interaction. (RH)

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ADVANCES IN CHILD DEVELOPMENT

Theory and Research

Edited by
ANDREW R. NESDALE
CHRIS PRATT
ROBERT GRIEVE
JEFF FIELD
DAVID ILLINGWORTH
JOHN HOGBEN

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First published in 1981
by the N.C.C.D. (National Conference on Child Development)
University of Western Australia, Nedlands, Western Australia 6009
Agents: Eastern States of Australia and New Zealand: Melbourne University
Press, Carlton
South, Vic. 3053; U.K. and Europe: Antipodean Books, 79 Grosvenor
Road, Muswell Hill, London N10, U.K.; U.S.A. and Canada: International
Scholarly Book Services Inc., Box 555, Forest Grove, Oregon 97116.
Printed by Quality Press, Osborne Park; bound by Printers Trade Services,
Belmont, Western Australia.

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© N.C.C.D. 1981 (National Conference on Child Development)

National Library of Australia Cataloguing-in-Publication data

Advances in child development.
'Developed out of a conference The National Conference
on Child Development, which was from August 18-21,
1980' Pref.
ISBN 0 9594161 0 2

1. Child development. 2. Child psychology. I. Nesdale,
Andrew R. II. National Conference on Child Development
(1980: Perth, W.A.)

155.4

CONTRIBUTORS

E. Allen, Department of Psychology, University of Western Australia, Western Australia.
M. Booth, Department of Psychology, Murdoch University, Western Australia.
J. Bowey, Departments of Psychology and Education, University of Western Australia, Western Australia.
J. Broerse, Mt. Gravatt College of Advanced Education, Queensland.
A. Buffery, Department of Psychology, University of Melbourne, Victoria.
D. Burnham, Department of Psychology, Monash University, Victoria.
L. Chan, Department of Education, University of Western Australia, Western Australia.
P. Cole, Department of Education, University of Western Australia, Western Australia.
B. Crassini, Department of Psychology, University of Queensland, Queensland.
T. Cross, Institute of Early Childhood Development, Melbourne, Victoria.
B. Dalgliesh, Department of Psychology, University of Queensland, Queensland.
R. Day, Department of Psychology, Monash University, Victoria.
P. Dermody, National Acoustic Laboratory, Sydney, New South Wales.
B. Drinkwater, Department of Psychology, James Cook University of North Queensland, Queensland.
J. Field, Department of Psychology, University of Western Australia, Western Australia.
J. Field, Department of Psychology, University of New South Wales, New South Wales,
J. Goodnow, Department of Psychology, Macquarie University, New South Wales.
R. Grieve, Department of Psychology, University of Western Australia, Western Australia.
L. Harris, Department of Psychology, University of Western Australia, Western Australia.
A. Hayes, Schonell Institute, University of Queensland, Queensland.
E. Ihsen, Department of Psychology, Monash University, Victoria.
D. Illingworth, Department of Psychology, University of Western Australia, Australia.
P. Jools, Department of Psychology, Macquarie University, New South Wales.
R. Knight, Department of Psychology, Macquarie University, New South Wales.

C. Lawrence, Department of Psychiatry, University of Western Australia, Western Australia.
K. Mackie, National Acoustic Laboratory, Sydney, New South Wales.
M. McCorriston, Department of Psychology, Monash University, Victoria.
H. McGurk, Department of Psychology, University of Surrey, U.K.
B. McKenzie, Department of Psychology, Monash University, Victoria.
C. Peltola, Department of Psychology, University of Queensland, Queensland.
S. Phillips, Department of Education, University of New South Wales, New South Wales.
R. Power, Department of Psychology, Macquarie University, New South Wales.
C. Pratt, Department of Education, University of Western Australia, Western Australia.
A. Richardson, Department of Psychology, University of Western Australia, Western Australia.
S. Rolfe-Zikman, Department of Psychology, Monash University, Victoria.
M. Schwartz, Lincoln Institute of Health Sciences, Melbourne, Victoria.
G. Seagrim, Department of Psychology, Australian National University, Australian Capital Territory.
J. Taplin, Department of Psychology, University of New South Wales, New South Wales.
W. Tunmer, Departments of Psychology and Education, University of Western Australia, Western Australia.
R. Wales, Department of Psychology, University of Melbourne, Victoria.
J.G. Wallace, Department of Psychology, Deakin University, Victoria.
K. Whyte, National Acoustic Laboratory, Sydney, New South Wales.

PREFACE

This book contains a collection of papers which fall within the broad area of child development. The papers are grouped together into four sections consisting of perceptual, cognitive, and social development, and the development of language and communication. Each section includes theoretical and empirical contributions which reflect the diversity and vitality that prevails in these important areas of inquiry.

The book developed out of a conference, "The National Conference on Child Development", which was held at the University of Western Australia in Perth from August 18-21, 1980. Financial assistance for the Conference, and for the preparation of this volume, was provided by grants from the Perth Building Society, Swan Television and Radio Broadcasters, Bank of New South Wales, and ALCOA of Australia Limited. The Departments of Psychology and Education of the University of Western Australia also provided financial support and technical assistance. We gratefully acknowledge these contributions.

We are also indebted to Tony Gibbs, Jan Roberts, and Heather Davies for their invaluable assistance in organizing the Conference. The assistance of Simon Albrecht, Maria Burns, Herb Jurkiewicz and Sue O'Regan in the preparation and editing of the manuscript is gratefully acknowledged.

ARN, CP, RG, JF, DJI, JHH

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INFANTS' VISUAL PERCEPTION OF MOVING OBJECTS AT DIFFERENT DISTANCES

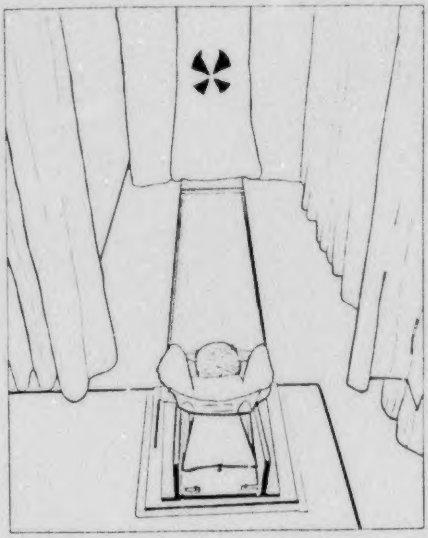
Elfriede Ihsen and Ross H. Day
Monash University

I am going to report the results of four experiments which explored infants' perception of moving objects at relatively great distances. In 1976 McKenzie and Day reported that object distance is a critical determinant of duration of fixation of a stationary stimulus for infants of 9 and 16 weeks. Fixation times decreased as the object was presented at increasingly greater distances from 30 to 90cm. However, this did not occur when the stimulus object was moving: even at 90cm a moving object was looked at for as long as it was at 30cm. Our experiments have explored infants' responses to moving objects located at distances beyond 1m.

The age of the infants in the four experiments was 8 to 14 weeks (mean 11.5 weeks) and there were eight subjects in each. The experimental arrangement was such that the visual environment of the infants was relatively homogeneous so that the stimulus was the only interesting object for the infants to look at. This can be seen in Figure 1.

We chose objects which are known to elicit long fixation times in infants of this age. They were three-dimensional with complex, high-contrast patterns on their frontoparallel planes and they were rotating at a speed of 7.5 rpm. The patterns were well above the visual acuity threshold of infants of this age.

Figure 1



The stimulus was attached to a stand which was high and wide enough to conceal a standing person. This stand could be moved forwards and backwards to different distances along the line of regard of the infants who sat in a reclining position with their eyes at the same level as the centre of the stimulus objects.

The time the infants fixated the stimulus objects was recorded. Generally in studies where "time of fixation" is the dependent variable, the criterion of "fixation" is the corneal reflection of the stimulus over the pupillary opening. But this "corneal reflection" is not observable when distances exceed 1m. The criterion for stimulus fixation in these experiments therefore was "direction of gaze", i.e., the infant was assumed to fixate the stimulus when he/she was looking in its direction. In the first experiment fixation times were recorded from behind the stimulus stand through a small aperture positioned directly above the stimulus. Judgments of direction of gaze were found to be reliable: the correlation between the fixation time scores of two independent observers was 0.98.

The stimulus was a cylinder patterned with a black and white Maltese Cross, rotating at 7.5 rpm (see Figure 1). It was presented at nine distances from 0.3 to 4m under two size conditions. These are shown in Slide 2.

In one part of the experiment the retinal size of the stimulus object was held constant at 5.7°: progressively larger cylinders were presented at increasing distances. In the other part of the experiment object size was held constant; a cylinder of intermediate size was presented at all nine distances. The order of the distances within each size condition was randomly varied.

Figure 2

Stimulus sizes and distances (Exp.1)

	Retinal Size Constant			Real Size Constant		
Stimulus	Diameter (cm)	Distance of presentation (cm)	Visual angle	Diameter (cm)	Distance of presentation (cm)	Visual angle
1	3	30	5.7°	20	30	38°
2	5	50	5.7°	20	50	22.8°
3	10	100	5.7°	20	100	11.4°
4	15	150	5.7°	20	150	7.6°
5	20	200	5.7°	20	200	5.7°
6	25	250	5.7°	20	250	4.6°
7	30	300	5.7°	20	300	3.8°
8	35	350	5.7°	20	350	3.3°
9	40	400	5.7°	20	400	2.9°

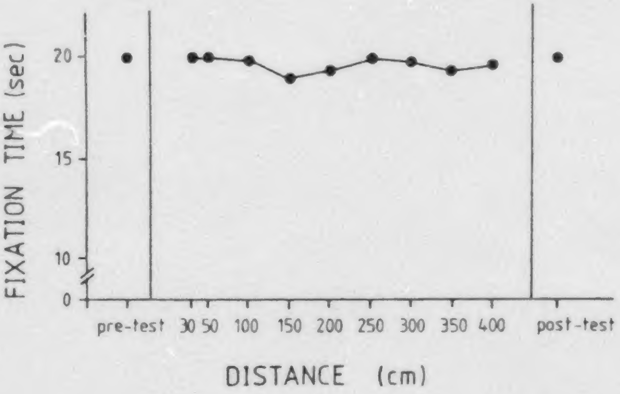
Total fixation times were recorded during each of the trials. A trial started at the moment the infant began to fixate the stimulus object and lasted for 20 seconds.

At the beginning and at the end of each condition a rotating multicoloured cube was presented at 1.5m. This pre- and post-test was included to ascertain possible fatigue effects.

The results of Experiment 1 are shown in Figure 3.

Unexpectedly it was found that once the infants detected the stimulus object they often continued to fixate it for the duration of the 20 second trial, regardless of its distance. On 50% of the trials the subjects looked for the whole 20 seconds, on 38% for between 15 and 20 seconds, and 12% for less than 15 seconds. A skewed distribution resulted and non-parametric statistics were used for data analysis. All the averages are therefore medians rather than means. A Friedman two-way analysis of variance established that there was no difference between size conditions ($\chi_r^2(2) = 0$, $p > 0.05$). The data from those conditions were thus combined to analyse whether fixation times decreased as a function of increasing stimulus distance. A second Friedman two-way ANOVA showed that this was not the case ($\chi_r^2(8) = 8.8$, $p > 0.05$). Figure 3 illustrates this very well: the data almost form a straight line.

Figure 3



There was no decline in attention over trials as assessed by comparing the pre- and post-test scores ($T(4) = 3$, $p > 0.05$).

The first experiment thus established that infants look at a rotating object for a considerable period of time even though it is as far as 4m away. The next question was whether even greater stimulus distances would affect fixation times.

The aim of the second experiment was thus to investigate infants' responses to rotating cylinders located at distances between 3 and 10m. The distances are shown in Figure 4. The six larger cylinders of Experiment 1 were used but as they were presented at greater distances, they projected smaller retinal images: about 2.2° to 2.9° visual angle. The rotary movement was of the same speed as in Experiment 1. As no difference was found between size conditions in Experiment 1, infants were only tested in the retinal size constant condition.

Figure 4

Stimulus sizes and distances (Exp. 2)

Stimulus	Diameter (cm)	Distance at which presented (m)	Visual angle
4	15	3	2.9°
5	20	4.5	2.5°
6	25	6	2.4°
7	30	7.5	2.3°
8	35	9	2.2°
9	40	10	2.3°

The same stimulus stand was used. However it proved to be impossible to see the direction of infant's gaze from distances beyond 5m. Therefore fixation times in this experiment were not recorded from behind the stand but from behind a "hide" positioned between the stimulus and the subject, 2.2m away from the infant. This hide was below the eye level of the infants. The small aperture in the hide through which the infant was observed was in line with their line of regard.

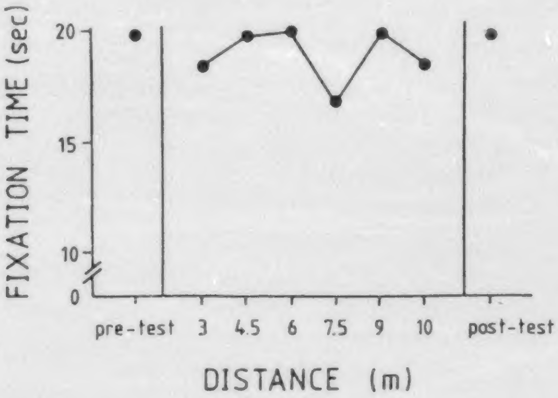
Careful calibration showed that the judgment of the direction of looking could be made reliably and accurately. This was demonstrated by the following test:
While I looked at the infant from behind the hide an assistant moved one of the cylinders on either side or above the stimulus stand or it was rotated in its correct place. I was blind to the conditions and wore earphones. My task was to state by forced choice the position of the stimulus object by observing the infant's direction of gaze. This test was executed on 18 trials with two infants and at two distances, 4.50m and 9m. I was correct on every trial in ascertaining the location of the stimulus object from the infants' visual behaviour.

In Experiment 2 there were six distances whose order was randomly varied and there was also a pre- and post-test. Trial length was 20 seconds starting from initial fixation. Total fixation times were recorded.

The results are similar to those of Experiment 1 and are shown in Figure 5.

On 45% of the trials the infants looked for the whole length of the trial, 20 seconds. On 40% of the trials infants looked between 15 and 20 seconds and on only 15% fixation times were less than 15 seconds. The distribution of scores was again skewed and non-parametric statistics were applied. Group averages are thus medians. A Friedman two-way ANOVA revealed no effect of distance ($\chi_r^2(5) = 11.66$, $p > 0.05$), that is infants looked equally long at near and far objects. Although it might appear that infants looked for shorter periods at the 7.5m stimulus, this score was in fact not different from the others, ($T(6) = 1$, $p > 0.05$). There was no difference between pre- and post-test. These results demonstrate that infants look at rotating objects for some 20 seconds even when they are up to 10m away. In both Experiments 1 and 2 it seemed that there was a ceiling effect due to the fixed trial length of 20 seconds.

Figure 5



Therefore we cannot infer that increasing object-infant distances do not affect fixation times but it can safely be concluded that a certain amount of interest in a moving object is maintained even when it is located at relatively great distances. On the other hand, as McKenzie and Day (1976) have demonstrated, stationary objects are hardly looked at when they are only 1m away. The greater salience of a moving object seems to be a determinant of infants' attention even at 10m.

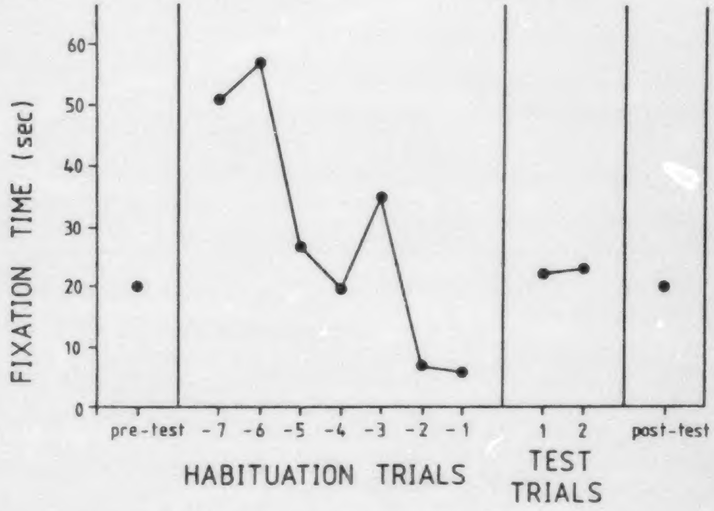
It seemed of little interest to us to establish at what distances infants will actually cease to look at moving objects. Instead we proceeded to investigate what it is the infants see at these relatively great distances. More specifically, we asked the question: do infants simply respond to movement alone, possibly in a reflexive manner, or can they see the features of an object that is moving at a distance and can they discriminate between two distant objects?

We examined infants' ability to discriminate between two stimulus objects rotating at 4m in the third experiment and at 10m in the fourth using the habituation/recovery paradigm. Infants were habituated to one stimulus until they reached a relative criterion (50% or less of the mean of the first three habituation trials on two consecutive trials), and tested with a novel one on two trials. We were also interested to see whether differences in fixation times as a function of distance are observed when duration of first fixation with an indefinite trial length is the dependent variable. In Experiments 3 and 4 trial length therefore was controlled by the infant; a trial started at the moment of initial fixation and was ended when the infant had looked away for about two seconds.

The stimulus objects presented in both experiments were the largest of the cylinders used in Experiments 1 and 2, and a cube which was similar in size to the cylinder. The pattern on the cube's fronto-parallel plane was a 3 x 3 black and white checkerboard which approximated the amount of contour, area of black and white, and number of pattern elements of the Maltese Cross on the cylinder. Both patterns are reversible figures. The stimulus objects were rotating at 7.5 rpm.

In Experiment 3 the stimuli were presented at a distance of 4m only and fixation times were recorded from behind the stimulus stand as in Experiment 1. Four subjects were habituated to the cube and tested with the cylinder. The pre- and post-test stimulus was the multi-coloured cube used in Experiments 1 and 2. It was presented at 1.5m for 20 seconds. The results of Experiment 3 showed that initial fixation times of the two stimulus objects did not differ significantly (Mann-Whitney U test: ($\underline{U}(4) = 2$, $\underline{p} > 0.05$ two-tail). The infants looked for a median of 58.4 seconds on the first habituation trial. The backward habituation curve in Figure 6 illustrates other results. All infants reached the relative criterion during habituation and the looking times on pre- and post-tests did not differ significantly ($\underline{T}(2) = 0$, $\underline{p} > 0.05$). The visual attention of all infants increased upon the presentation of the novel stimulus object by at least 40%. The differences between scores of the last two habituation trials and the two test trials was evaluated non-parametrically as the variances were non-homogeneous. A Friedman two-way ANOVA established that the infants looked significantly longer in the test phase ($\chi_r^2(1) = 8$, $\underline{p} < 0.01$).

Figure 6

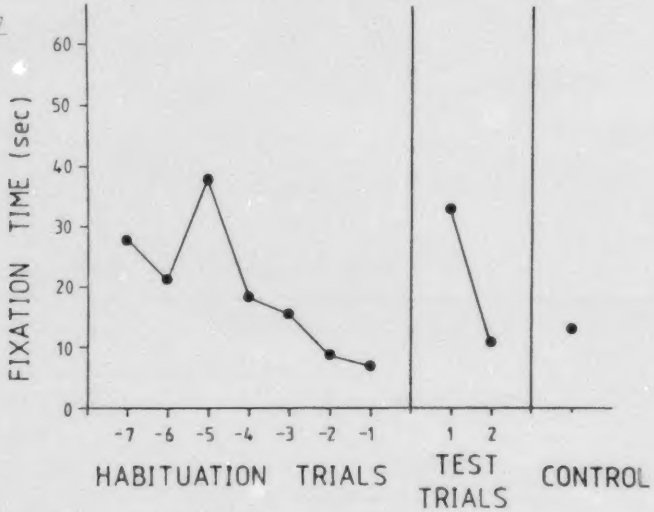


These results suggest that infants of about 2-3 months can discriminate between two differently shaped and patterned moving objects which are 4m away. They responded to the novelty of the test stimulus with increased fixation regardless of whether it was the cylinder or the cube. Clearly the distinguishing features of both objects must have been perceived.

In the final experiment we extended the enquiry to objects rotating 10m from the infant. The same two stimulus objects (the cylinder and the cube) were used. The stimulus stand was positioned 10m away from the infant. Fixation times were recorded from behind the hide, as in Experiment 2. The procedure and the design was identical to Experiment 3 except that no pre- or post-tests were conducted. Instead, the habituation stimulus was represented in the testphase. If the response to this stimulus remains low, whereas that to the novel stimulus increases, one can infer that a decrease in fixation was due to the infants' stimulus-specific habituation rather than to general fatigue. The presentation order of novel and familiar stimulus was counterbalanced in the test trials.

In this experiment the initial fixation time was 53.7 seconds and again both stimuli were looked at for a similar length of time ($\underline{U}(4.4) = 9$, $\underline{p} > 0.05$). Figure 7 shows the backward habituation curve obtained from the results of Experiment 4. All infants reached the relative habituation criterion. Only one subject did not recover from habituation upon the presentation of the novel stimulus. All others increased their responses by at least 20% on the first test trial. A Friedman two-way ANOVA showed that there was a main effect of trials,

Figure 7



i.e., the last two habituation trials, two test trials and control, ($\chi_r^2(4) = 10.38$, $p < 0.05$). Post-hoc nonparametric pairwise comparisons (Levy, 1979), determined that this effect was due to the difference in fixation times on the last habituation trial and the first test trial ($|\bar{R}_{-1} - \bar{R}_1| = 2.37$, $\omega q_{0.05,\, 5,\, \infty} = 2.16$, $p < 0.05$). This was the only difference which was significant.

As in the third experiment the data clearly suggest that infants can discriminate between two stimulus objects which rotate at a relatively great distance, here at 10m. It seems therefore reasonable to conclude that infants of 8-14 weeks do not simply respond to the movement of distant objects but that they actually perceive an object characterised by certain features. Presumably the objects are discriminated in terms of these features.

Finally, the duration of fixations on the first habituation trials in Experiments 3 and 4 confirm the results of Experiments 1 and 2: infants do attend to rotating objects which are 4 and 10m away. The supposition that there was a ceiling effect due to the fixed trial procedure adopted in the first two experiments seems confirmed by the finding that infants will look much longer than 20 seconds if they are allowed to. The median fixation time on the first habituation trial across all subjects in the third experiment was 58.4 seconds, that in the fourth experiment 53.7 seconds. The difference is not significant ($U(8,8) = 28$, $p > 0.05$). We therefore suggest that an increase in the distance between the rotating object and the infant from 4 to 10m did not affect attention to the object.

In conclusion, the results of these experiments suggest that the extension of the visual field of 8-14 weeks-old infants is much greater than was previously assumed.

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LONGITUDINAL CHANGES IN CONTRAST SENSITIVITY

David Illingworth
University of Western Australia

Human and animal studies indicate significant developmental changes in the visual system after birth (Blakemore, 1974; De Valois & De Valois, 1980). One index of change in vision is the ability to resolve spatial detail.

Visual acuity may be defined as the finest detail discriminable. The standard clinical investigation (Snellen) involves high contrast stimuli. It has two important limitations. Firstly, the visual system is more sensitive to contrast at certain spatial frequencies; Snellen acuity gives only the finest detail resolvable at maximum contrast. Secondly, the subject is required to both read and respond to letter stimuli and thus it is not useful in subjects with reduced reading skills. A more comprehensive method is the visual contrast sensitivity function (CSF) which indicates the contrast levels required to distinguish objects of different size from their background (Campbell & Maffei, 1974) i.e., the contrast threshold for detecting gratings of different spacing (spatial frequency). The advantage of measuring the CSF lies in its completeness, its parsimony, and its interpretative clarity.

Estimates (from CSFs giving approximate Snellen acuities) indicate the finest detail a neonate can resolve is about 0.85 cycles/degree (c/deg) of visual angle (20/705) (Atkinson, Braddick & French, 1979), while 2-month-old infants resolve about 2 c/deg (20/320) (Harris, Atkinson & Braddick, 1976); human adults resolve 30 c/deg (20/20) and adult cats resolve 6 c/deg (20/100) (Berkley, 1976). While some allowance must be made for the method used, in that electrophysiological estimates are usually higher than behavioural ones (Dobson & Teller, 1978), these studies show rapid early development for high spatial frequencies (fine detail) reaching adult levels before the end of the first year of life (Pirchio, Spinelli, Fiorentini & Maffei, 1978).

Recently, an extensive study of CSFs in different age groups demonstrated children do perform at lower levels than young adults (Beazley, Illingworth, Jahn & Greer, 1980). These data show a clear upward trend (relatively constant over all spatial frequencies) which is age related with no sex differences. One limitation is the cross-sectional nature of the data whereas longitudinal designs provide some insight into individual developmental functions (Wohlwill, 1973; Nesselroade & Baltes, 1978).

The purpose of this paper is to report two longitudinal studies of the CSF; one against the background of sudden direct insult to the visual cortex, the other of slow, insidious changes consequent on impaired optics (left convergent squint). Thus, a further advantage of the CSF is as a diagnostic aid (Bodis-Wollner, 1976; Hess & Howell, 1977; Regan, Silver & Murray, 1977; Arden, 1978).

Method

Subjects. Of the total of 135 subjects tested, 14 were 9-year-old children and 17 were young adults (18-29 years, $\overline{X} = 22.5$) as well as G.R.

and A.S. Normal subjects were volunteers recruited from a wide cross-section of the population. All subjects were screened by a consultant ophthalmologist and were excluded if (a) there was < 20/20 (Snellen acuity) in both eyes for adults, and < 20/30 in both eyes for children (< 8 years of age), and (b) there was any gross ophthalmic symptom, e.g., squint, severe astigmatism, etc. G.R. and A.S. were tested at the ophthalmology clinic of the local children's hospital. Most children were very cooperative so that very few could not be tested.

Stimuli. Vertical sine-wave gratings were computer-generated in the conventional way (Campbell & Green, 1965) and displayed on a Tektronix 604 monitor (P31 fast decay green phosphor). The mean luminance was 9.0 cd/m^2 while the trough luminance was 4.0 cd/m^2 giving a maximum contrast value of 0.5 where contrast is defined in the usual way as $(L_{max}-L_{min}/L_{max}+L_{min})$ where L_{max} and L_{min} are maximum and minimum luminance levels respectively. Contrast could be modulated directly by two attenuators (one moving in -10 db steps and the other in -1 db steps). The order or presentation of the seven spatial frequencies used (0.25 to 16.0 cycles/degree) was determined in a quasi-random sequence.

Subjects were seated 1m from the circular target which subtended 6.0 degrees of visual angle while the total surrounding field subtended 31 degrees. The immediate surround was matched approximately in average luminance and colour to the target grating. Ambient light (about 2 cd/m^2) and noise were controlled. All testing was carried out in a mobile caravan specially equipped for the purpose.

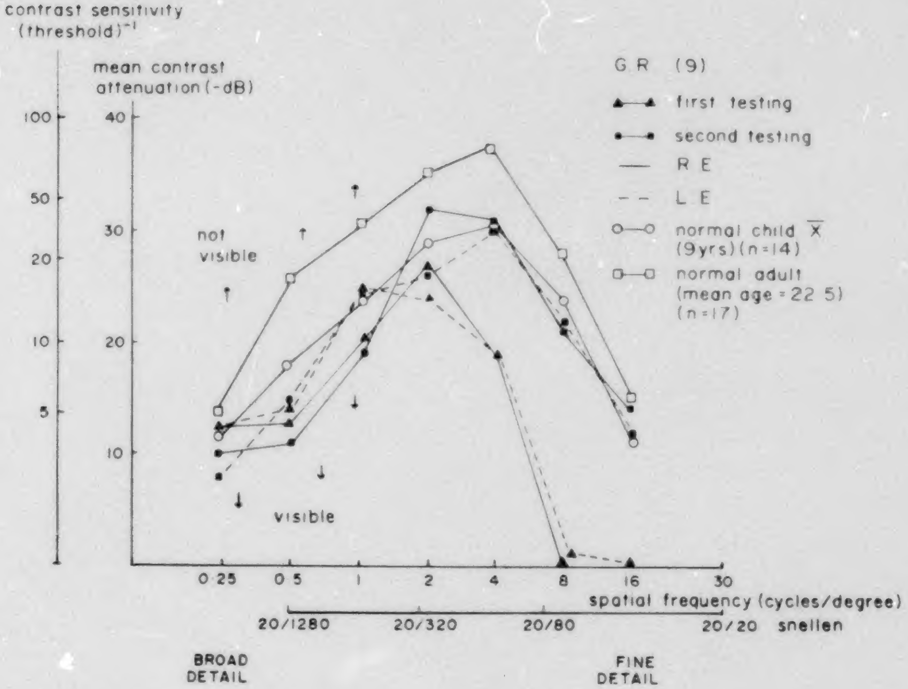
Procedure. Special care was taken to encourage optimal motivation in children and adults using standard instructions to promote clear understanding of the task. Double random staircase procedures were adopted to establish a threshold value for each spatial frequency (Cornsweet, 1963). Between trials to prevent boredom and habituation effects, coloured slides of animals or cartoon characters (matched for target luminance and overlaying the target stimulus) were shown to increase the children's attention. All aspects of the experiments were under real time computer control including plotting of CSFs, thus the experimenter could monitor the subjects' behaviour free from recording tasks.

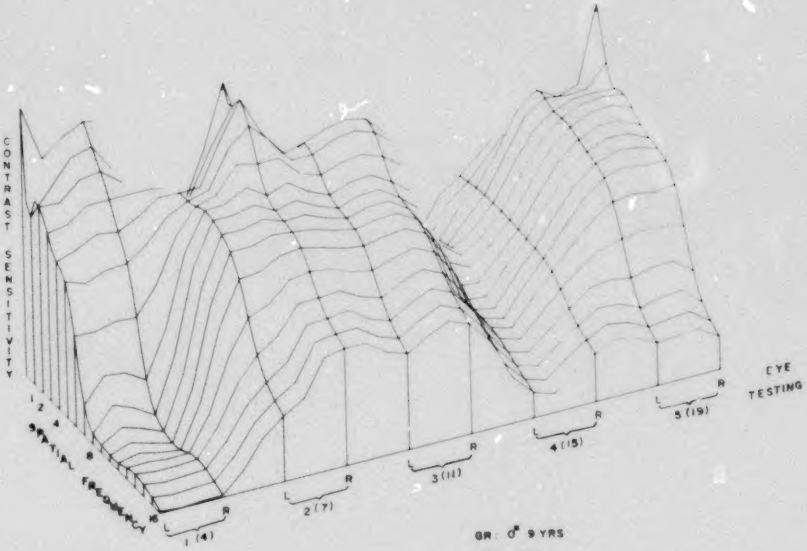
Results

An alternative to normative comparisons is to track each individual over time using the individual's performance as a baseline for comparison (Nesselroade & Baltes, 1978). Figure 1 illustrates the case of a 9-year-old boy involved in a motor vehicle accident resulting in a depressed occipital fracture and left hemiparesis. After neurosurgical intervention, he made rapid recovery and was discharged. Four months after the incident he complained of dizziness and poor vision. After standard ophthalmological examination (Snellen acuity, Left 20/80, Right 20/80, or about 6/24 in each eye), he was referred for measurement of contrast sensitivity.

As indicated earlier the CSF very accurately assesses an individual's ability to see objects over a wide range of viewing conditions. Figure 1 reports two successive testings of the subject four and eight months

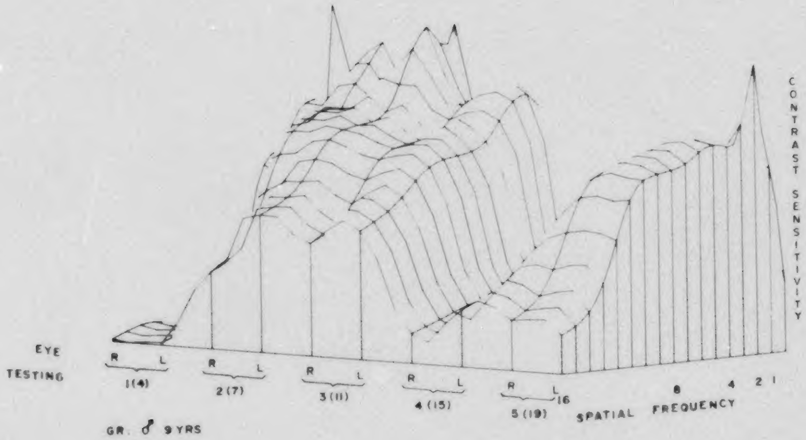
fig 1. CONTRAST SENSITIVITY FUNCTIONS FOR NORMAL ADULTS, NORMAL 9YR CHILDREN AND "GR"





GR. ♂ 9 YRS
AZIM. 65°
ELEV. 30°

Figure 2



GR. ♂ 9 YRS
AZIM. 135°
ELEV. 5°

Figure 3

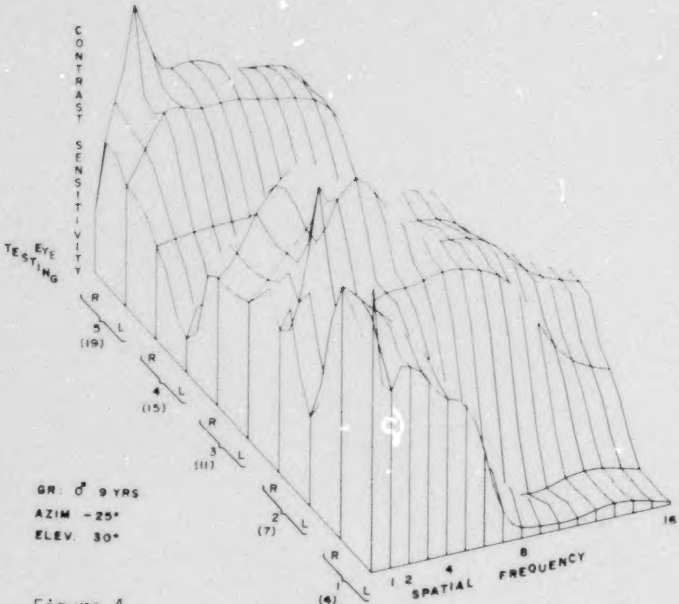


Figure 4

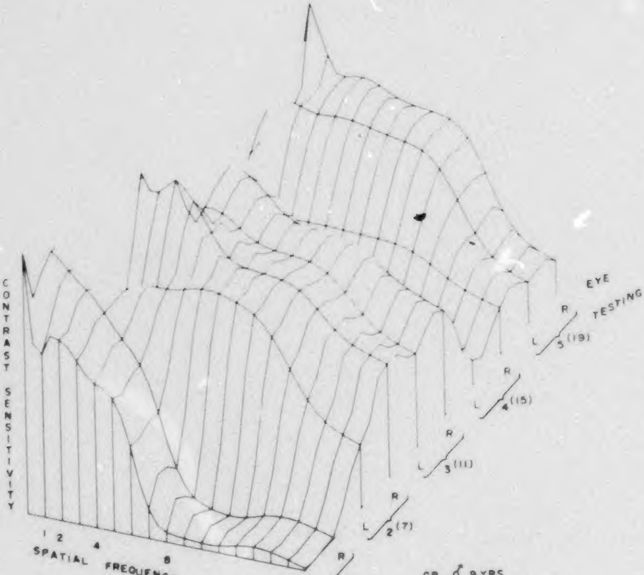


Figure 5

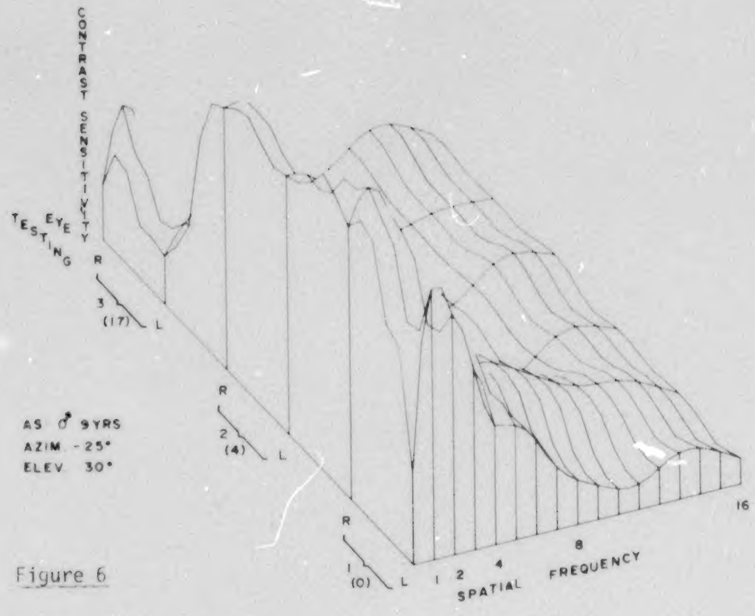


Figure 6

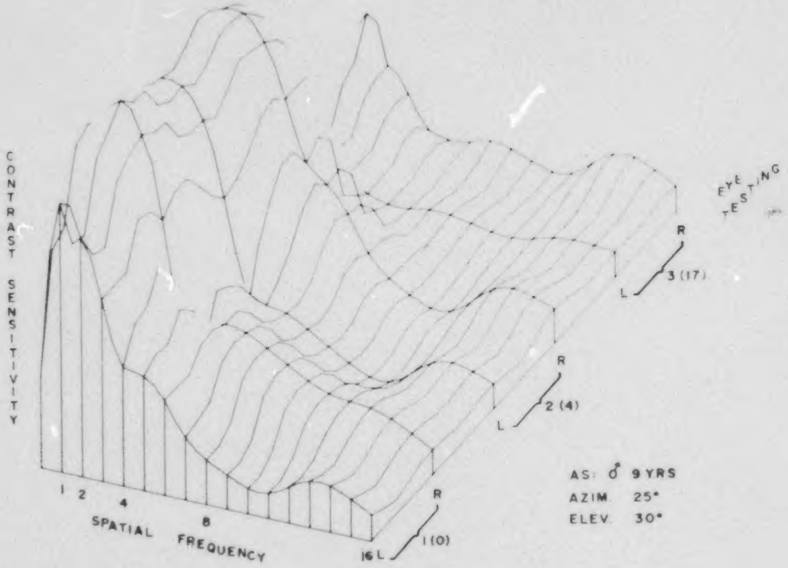


Figure 7

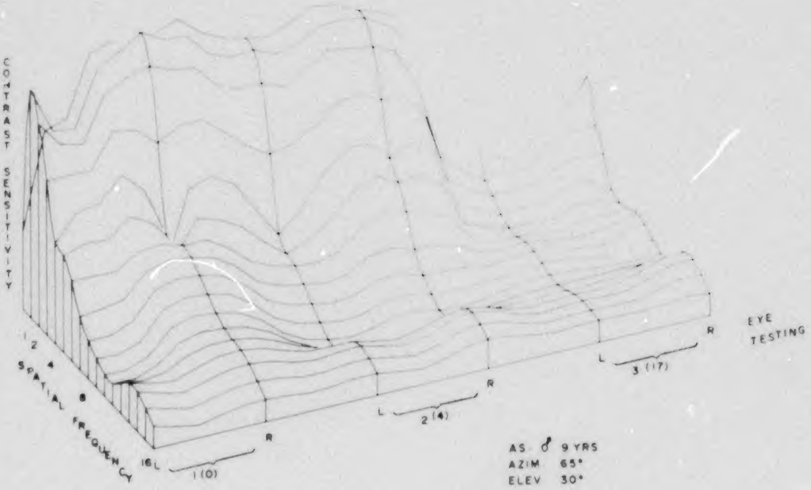


Figure 8

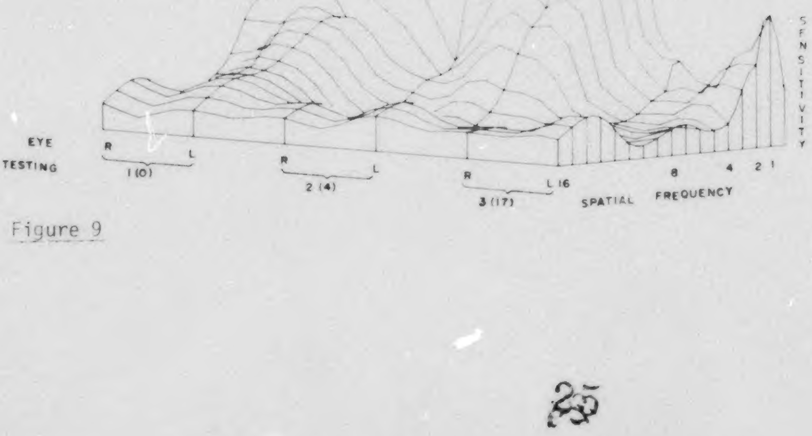


Figure 9

after his accident as well as the mean performance of normal 9-year-olds and young adults on the same test. Visual inspection shows both eyes are similar (as expected) but there is a profound loss in visual efficiency in the high spatial frequencies, e.g., at 3 cycles/degree (approx. 20/80 Snellen) i.e., about -24 db loss or a 200% decrease in efficiency.[3] At this time the subject was unable to see fine detail effectively and thus the author was able to corroborate the expressed difficulties in reading, etc., in his schoolwork. Subsequent testing at eight months post accident showed his recovery approached expected age levels. The advantage of this type of analysis comes from having a precise quantitative index of recovery. Further testings are depicted in Figures 2 and 3.

Figures 2-5[4] summarise various testings in a three-dimensional map (Sampson, 1978) from several different azimuths and elevations (the origin of the two-dimensional figure is the south-west corner in Figures 2 and 4 respectively). It can be clearly seen from examination of the several slopes, that there is a remarkable recovery in the high spatial frequencies in the months after the accident. The pattern continues except for a sharp trough about 15 months post accident. The dizzy spells and poor vision returned and were accompanied by a change in lability of G.R's personality suggesting frontal lobe as well as occipital lobe insult (Walsh, 1978; St James-Roberts, 1979).

A.S. was also a 9-year-old boy at first testing. He had a congenital left convergent squint which had been treated by surgery at 13 months of age and short term patching of the good eye at two years as well as extended treatment on the CAM wheel (Watson, Banks, Campbell & Hess, 1978). This study is of interest partly for classificatory purposes (Hess & Howell, 1977), and also for detecting whether there is any long term change in this condition.

The pattern for A.S. is quite different, (see figures 6-9). Again both eyes are similar, being initially like one of the two types classified by Hess and Howell. In Type "A", the CSF is depressed only for high spatial frequencies but for Type "B" all spatial frequencies are depressed. At the final testing there was a dramatic loss over all spatial frequencies. The important finding here is that even after considerable treatment visual efficiency continues to decline counter to expected development (Beazley, Illingworth, Jahn & Greer, 1980).

Discussion

Both studies illustrate the importance of measuring sensitivity at all spatial frequencies and not just at the upper limit (e.g., Snellen acuity). Further, the contrast sensitivity function gives a precise quantitative index of aberrant visual system changes whether the cause is sudden or insidious.

There is the question of what should be the focus in developmental neuropsychological assessment. Apart from very severe traumatic events or severe congenital problems, the life expectancy of the child is considerable. Therefore, what information should the neuropsychologist seek about the child with a brain insult? What the child can do? Or what he can't do? Traditionally, the focus of testing is concentrated on the latter, rather than the former. Too often "deficits" (read permanent disability) are evaluated without consideration for "assets"; yet the research evidence (Baltes & Baltes, 1980) clearly shows that even in old age some abilities like crystallised intelligence (test performance associated with formal education and experience) not only continue to increase but are significantly superior to those found in young adults.

Thus, realistic rehabilitation programs must be based on what the child can do and not be misled by what he can't do. In both studies there were clear specific changes which might be assisted by reference to basic research material, e.g., high spatial frequencies (fine detail) are easier to see in brighter light. The provision of very bright light assisted G.R. to continue his reading program and contributed to a better adjustment after the accident. Regrettably, in the second case, the long term tuning of the CNS probably allows little hope for remediation (Hess & Howell, 1977). Finally, longitudinal designs reveal most about change in the individual child.

Footnotes

1. Acknowledgement is given of the generous cooperation of the medical staff of Princess Margaret Hospital (PMH) for Children, Subiaco, Western Australia for access to their patients (G.R. and A.S.). Also we wish to thank the children and their parents, who participated so willingly in these studies. This research project is supported by the National Health and Medical Research Council of Australia (Grant No. 78/126) and TVW Telethon Foundation (for Medical Research).

2. All luminance measurements were made using a Tektronix J16 Digital Photometer.

3. As a rough idea of this deficiency, stretch your index finger at arm's length, imagine eight stark white and black bars painted on your fingernail; easy to see? Of course, now reduce the whiteness and blackness toward greyness by 200%, then you can "see" the difference between what G.R. could see at the first testing and what he should see if his vision were normal.

4. Figures 2-9, Times of testings, (months), given in parentheses.

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THE DEVELOPMENT OF THE OBJECT CONCEPT IN EARLY INFANCY

R.H. Day
Monash University

A few casual observations and a little reflection will readily show that a considerable proportion of our time as adults, if not nearly all of it, is taken up with the business of dealing with objects. By the term "objects" I do not mean only manipulatable, palpable entities such as pens and pencils, tools, cakes of soap, knives and forks, chairs and books, and tin cans, but other people, other peoples' faces, doors and windows, food, clothing, holes in the ground, and, very importantly, pictures of these things--all those items and articles with which we have transactions from moment to moment throughout most of our daily lives.

As well as handling, avoiding, approaching, eating and using objects in one way or another--that is, dealing with them physically--we perceive them and deal with them cognitively. That is, we are conscious of their representations--we classify them, distinguish between classes, discriminate between members of a particular class, identify particular objects, recognise their properties and, furthermore, recognise them when their representation at the eye, ear and skin vary widely. We also identify and recognise objects when they are themselves changed--we recognise an umbrella when it is opened or furled, a sponge when it is squeezed or unsqueezed and a face when it is painted or unpainted. These capacities, best called perceptual-cognitive capacities, are developed to a high degree in normal adulthood. So much so that not unnaturally they are taken for granted--accepted, as it were, as a natural feature of maturity. But of course, such capacities must have a beginning and develop to the stage of refinement with which we are familiar. They are clearly not present at birth and they are by no means fully developed at the end of the first year.

It is with the emergence of this perceptual-cognitive facility with objects--the emergence of detection, discrimination, identification and recognition of objects in the first year of human infancy that I am mainly concerned here. I want in particular to discuss our experiments on figure and object perception in the first few months, those on the far-from-resolved issue of perceptual constancy, and those on the recognition of objects when they are transformed over space and time.

Let me make quite clear what I mean by the term "perception". I prefer to define it as--the representation in consciousness of external objects and events and of internal states. Responses such as visual fixation, recovery from habituation of looking, head-turning with reinforcement, and anticipatory behaviour can be regarded as indices of this conscious representation. From this standpoint the terms perception and cognition are inseparable; recognition and identification imply stored representations and a comparison between what is present and what is stored.

Some Early Findings

It is worth bearing in mind that some years ago we found that when a plain stationary object is more than about 80cm away it is hardly looked at by infants of between about 6 and 20 weeks (McKenzie & Day, 1972). This is so irrespective of whether the object is of constant size or constant visual subtense. However, a patterned object is looked at when it is further away and a moving, patterned object, such as a rotating drum, when it is much further away (McKenzie & Day, 1976). Indeed, babies of about 11 or 12 weeks will continue to look at an object as far as 10 metres away and, furthermore, identify it as a particular object--not merely as disembodied movement (Ihsen, 1979). It is also established that bright objects and complex patterns are of considerable interest to young babies. It is to be noted also that plain three-dimensional objects are of much greater interest than plain flat ones and large objects more so than small ones (Day & McKenzie, 1977).

The point in mentioning these findings from earlier experiments is to stress that objects and object properties vary greatly in their salience for the young baby. Some prove very interesting--especially moving ones--and others of little or no interest. Such salience was noted by Fantz (1967) a long time ago in his work on visual preference, and it has been confirmed on numerous subsequent occasions. I mention it not only because of its inherent interest but because it has implications for the design of experiments with infants. What is salient for babies are objects that are large, bright, complexly patterned, three-dimensional, and moving.

Form Perception and Relationships

Do very young infants--infants in the first three months--recognise forms or shapes, and if so, on what basis? And do they have to learn to do so, or is the capacity innate? Salapatek (1975), Gibson (1969) and Hebb (1949) have all concluded that shape perception begins with the perception of edges, angles and other features and that shapes are constructed in perception from these basic components. On the other hand, Bond (1972) and Hershenson (1967) have expressed the view that whole configurations are perceived first and that this capacity is probably innate, emerging in the course of maturation.

Dr. Schwartz (see Schwartz & Day, 1979) working in our laboratory has gone some way towards answering these questions. In a series of elegantly designed and conducted experiments she presented infants between about 8 and 17 weeks with a series of angles, shapes, and incomplete patterns. The infants were shown a particular stimulus object until the now well-established habituation of visual fixation had occurred and then, in a test phase, shown four stimulus objects, the same one as before and three new ones. The extent of recovery (dishabituation) served as a measure of discrimination. The results of the first three experiments showed clearly that the young baby is able to recognise a figure even when it is rotated through 90° and to use angular relationships within the figure to identify it. In a second group of three experiments she showed that a shape rotated through 45° is seen as more similar than another shape with different angles. Finally, using shapes with different degress of completeness of contour, Dr. Schwartz showed that it is not angles alone that are important in recognising the shapes of objects but the relationship between the various parts. Taken together the outcomes of these experiments indicate that as early as eight weeks of age the relationship between parts--between the angles or between the contours--serve to specify simple outline shapes. If this is occurring within eight weeks of birth it seems reasonable to conclude that shape perception is largely innate and that it is the whole shape that is perceived. We cannot accept that objects are constructed in perception out of separate elements, that the percept is a sort of building made of bricks.

Three general points about this work need to be borne in mind:

1. The observations are confined to two-dimensional outline shapes between 8 and 17 weeks;
2. Learning could occur in the first eight weeks, as Cohen (see Schwartz & Day, 1979) has argued from our data, although this seems to us unlikely; and finally,
3. The support for a Gestalt-like principle is clear; shapes of objects appear to be relationally determined. I shall return to this point in the final discussion.

The Object Constancies

Object properties appear to be the same regardless of the nature of the image they project at the eye. Koffka in his Growth of the Mind (1924/1959) made this point in discussing visual shape constancy. He said:

> . . . things in our environment may be seen from many different points of view, and in very different aspects, so that the same thing may be reflected upon the retina in a multiplicity of ways; yet as in the case of colour and magnitude, the actual phenomenon as it is given to the naive individual fails to follow these changes; instead a certain thing always appears with the same configurative qualities . . . .

Is this so in infancy? Some years ago McKenzie and I (Day & McKenzie, 1973) tackled this problem by comparing the rate of habituation of looking for a cube shown in a number of different orientations and in a single orientation. We argued that if the cube were perceived as having the same shape as its orientation varied, that is, if it were seen as the same object, the rate of habituation of looking would be no different from that for a single orientation. Incidentally, the frontal shape --the visual projection-- of a cube in different orientations varies very markedly indeed, far more than one might perhaps expect. As a control we included flat shapes carefully painted to resemble the cube in different orientations. We tested 48 babies between the age of 6 and 16 weeks and found that there was a significant decline in viewing time for the cube regardless of changes in orientation and no notable difference between the rates of habituation. However, there was no such decline for the flat representations which, incidentally, were looked at for much longer. These data indicated that shape constancy is operating in the age range 6-16 weeks.

This experiment has been criticised, we now feel quite justifiably, by Cook, Field and Griffiths (1978), and by Caron, Caron and Carlson (1979). The main grounds for criticism are simply that the young infants may not have been able to discriminate between solid forms so that the rate of habituation would be the same for the two critical conditions of our experiment. More recent work, however, has confirmed our results. Caron, Caron and Carlson (1979) using a different and more powerful experimental technique (see below) have convincingly shown that shape constancy is apparent at 12 weeks of age.

Visual size constancy, the apparently constant size of an object as it gets further away--one of the best established capacities of adult perception--has a longer and more mixed history. To reduce a long story to a sentence, some very unsatisfactory experiments were reported in the 1940s and 50s by Cruikshank (1941) and by Misumi (1951) and McKenzie and I (McKenzie & Day, 1972) failed to confirm the claim made by Bower (1965, 1966) that size constancy occurs at about two months for distances up to three metres. A year or so ago we (McKenzie, Tootell & Day, 1980) carried out a series of four experiments which showed that visual size constancy is certainly functioning by the end of the first half year, and, more recently, we (Day & McKenzie, in press) completed a better-designed experiment and confirmed our view that size constancy is in fact operating well within the first half year with approaching and receding objects.

In the first group of experiments, infants viewed "interesting", stationary objects in the form of modelled human heads. One was normal size, the other half size. In the two experiments I want to concentrate on, these objects were viewed from 30 and 60cm by 4-month-old and 6-month-old babies. Again we used the habituation-recovery procedure. The standard test was always the large head at 60cm. There were four test conditions--the large head at 30cm, the small head at 30cm, the large head at 60cm (the control), and the small head at 60cm. That is, we tested for all possible combinations of size and distance. The results were quite clear; the 6-month-old infants continued to respond to the same-sized head when it was 60cm away in the same way as they did when it was 30cm away; that is, there was little recovery from habituation. The recovery for a different-sized head was marked for both distances. These outcomes indicate that size constancy is present and operating. For the 4-month-old infants the outcomes were different; although they recovered from habituation there was no overall difference between the four groups. However, some of the infants, those with the smallest variance, clearly showed the same sort of recovery pattern as the older infants. In brief, at 6 months visual size appeared to be present whereas at four months it was much less apparent.

But there is a curious paradox in these results. Shape constancy is manifest at about three months and size constancy not until about six months. That's a big difference when it is remembered that both these capacities rest on information for depth, i.e., on distance and slant in depth respectively. Of course, there is no a priori reason why they should not emerge at different stages; shape constancy might be much more critical in the infant's scheme of things. There is also the possibility that our method might have been too insensitive. For these reasons we ran another experiment on size constancy using a quite different procedure with 4-month-old babies (Day & McKenzie, in press). In fact, it was essentially the same method as used by Caron, Caron and Carlson (1979), for shape and earlier by Gibson, Johnson and Owsley (1978) in a study of visual transformation. I am bound to say, however, that we hit on the method quite independently.

The modelled head was moved towards and away from the baby through a fixed distance but from different starting points. By using different starting points the baby saw the object moving through a variety of distances and subtending a range of visual angles while doing so. When habituation had reached a predetermined criterion we ran two test trials, one with the same object and one with the one of different size, each moving through a new distance from a starting point but in the same *range* of distances and visual angles as before. Thus if a greater recovery occurred for the novel-sized head it could only be due to size --not to distance or visual angle because the baby would have habituated to both of these. The results were quite convincing; significant recovery occurred for the novel size but not for the familiar size, indicating that size constancy is present at *four months*. Incidentally, recovery was markedly greater in going from the small to the large object than it was in going from the large to the small, emphasising the need for carefully balanced designs in experiments of this sort.

Last year in a major statement on infant visual perception Cohen, DeLoache and Strauss (1979) concluded:

> . . . the evidence for perceptual constancies under 6 months of age is equivocal at best. At 8 to 10 months there is a hint of shape constancy, a lack of support for egocentric constancy, and no information on the existence of size constancy . . . .

We can now modify that statement; shape constancy according to our work and that of the Carons is operating at about three months, and size constancy at four months.

Egocentric Constancy

When in 1977 Dr. McKenzie and I (Day & McKenzie, 1977) reviewed the findings on perceptual stability with a changing sensory representation we made a distinction between the object constancies and the egocentric constancies. The egocentric constancies refer to the stability of objects and events as the *observer* changes position and orientation. For example, when we tilt our heads or lie down the perceived world remains upright and stable although the orientation of its image at the eye has changed. Somewhat similarly, when we change position in a room so that a table at first on our right is now on our left we continue to see it in the same--or constant--position *in the room*, even though it has changed relative to ourselves. Is this so with babies, and, if so, how early?

This problem has a relatively short history. Acredolo (1978) tested infants of between 6 and 16 months and found what we call position constancy at 16 months, not earlier. Bremner and Bryant's (1977) data are broadly in agreement. However, Rieser (1979) last year found some tenuous evidence for position constancy at six months. We are currently engaged in an experiment on this problem using what we believe to be an improved design. The baby, seated on the mother's lap, observes one experimenter disappear from view and, a few seconds later appear in a window to one side. This procedure is repeated until the baby learns to anticipate the appearance of the experimenter in the window. This learned anticipation is indexed by a head-turn to the window before the experimenter appears. When this response has been acquired the experimenter again disappears and the baby-- still on mother's lap--is rotated through 180°. Now, if the child perceives the window towards which he has learned to turn as being in a constant position *in the room*, i.e., if he has position constancy, he will look towards it with, of course, the opposite direction of head-turn. If, on the other hand, the baby has learned only to make head-turns, right and left relative to himself, he will continue to do so. The data, just to hand, show that at 12 months four out of 10 subjects anticipated the correct position while five did not. One did not respond at all. At 14 months eight out of 10 responded in terms of position, one egocentrically, and one not at all. Thus it seems that position constancy is not present--at least as we have indexed it--at 12 months but is becoming apparent at 14 months. It is conceivable --as always--that our method lacks sensitivity, but by and large our results square with Acredolo's (1978) and Bremner and Bryant's (1977) but not with Rieser's (1979) findings. We have to do a lot more work on this problem but I think it reasonable tentatively to conclude that position constancy is beginning to emerge in the first months or so of the second year. Clearly, however this form of perceptual constancy seems to fall in a quite different class of perceptual attainments than the earlier-developed object constancies.

Recognition of Transformed Objects

It is characteristic of objects in our environment that they change not simply in terms of their representation at the eye--as I have been so far discussing--but in terms of their actual features. Many objects change in colour, shape, size, position and stationariness. A face changes in colour with sunburn and in shape with smiling and frowning, a sponge or soft toy in shape with squeezing, clothes as they are rumpled and tossed around, and people and vehicles as they move. With such transformations in object features does the baby continue to recognise the transformed object as the same object and, if so, how early in development does such an obviously important facility emerge? This is, of course, an aspect of the problem of what Piaget (1954) has broadly called object permanence--the capacity to appreciate the permanency of objects as they change over space and time. Piaget has argued that object permanence does not begin to develop until his Stage III (at about 4½ months) of the sensorimotor period. He suggests that it arises out of the infant's motor schema following manipulation and exploration of the object.

The development of what is sometimes called identity constancy with object transformation has been investigated in a series of experiments in our laboratory (Burnham & Day, 1979; Day & Burnham, in press).

What Burnham and I did was to show babies objects that were either stationary or moving at a particular speed. The babies were between about 8 and 20 weeks. After a fixed number of trials habituation of looking occurred. The subjects were then shown the same or a different object in a different state. If it had been moving it was shown when stationary (or moving at a different speed) and if it had been stationary it was shown as moving. We used two experimental arrangements, one in which a cross whose colour could be changed was stationary or rotating, and another in which patterned objects could be moved laterally across the baby's visual field. In the second arrangement a movie camera was located just above the laterally moving object and was timed to expose at about half-second intervals so that there was a permanent film record of visual following.

With rotating objects it was found that infants in the age range 8-20 weeks can recognise a familiar colour even when it changes from stationary to moving and vice versa. They also recognise the shape of laterally moving objects--triangles and circles--under transformed conditions. Incidentally, it is worth noting that the appearance of identity constancy at 8 weeks seriously questions Piaget's (1954) view that manipulations and explorations of the present object is deeply involved in the development of this capacity. Exploratory behaviour does not seem to be necessary for the internal representation of the object, which is, of course, essential for its recognition later.

Recognition after Transformation from 3D to 2D

Finally, in the last few years a number of experiments have been reported, which show that infants can recognise a two-dimensional representation of an object--a picture of an object--after having been familiarised with the real, three-dimensional object. Quite recently Rose (1977) has reported that 6-month-old babies can recognise a picture of a complex object after seeing the real three-dimensional object and, moreover, recognises the three-dimensional object after seeings its picture. For the most part faces and dolls and pictures of them have been favoured as stimulus objects. This year Amanda Norman, working in our group has familiarised 5-month-old babies with either three-dimensional or two-dimensional objects and then tested them to establish whether they can recognise that object when it is two-dimensional or three-dimensional. Although these experiments are still in progress the results in general show that with three-dimensional geometrical objects and their two-dimensional representations the 5-month-old baby recognises the two-dimensional form after seeing the three-dimensional form, but not vice versa. It is, therefore, now a matter of interest to find out at what age the perceptual skill of recognising an object from a picture emerges. So far we have not confirmed the two-dimensional to three-dimensional transfer reported by Rose (1977).

Summary

Let me now quickly summarise what I have told you and then try to impose some order on the data.

In the first half year of life and, in some instances, quite early in that period, infants have the perceptual capacity to make use of spatial relationships in recognising figures; they exhibit at least two of the classical object constancies, those of shape and size, but not position accuracy, the ability to see something in the same position in a room as they themselves are moved; they recognise an object when it changes from stationary to moving and vice versa, and when it changes in speed of movement; and they can recognise a picture of an object after seeing the object but not the object after seeing the picture. It seems that a great deal of the perceptual capacity of maturity is in operation in the first half year of life.

The Role of Relationships in Perception in Infancy

What then are we to make of all this? What sort of explanation can we even begin to make? I want to propose an explanation that owes something to the late James Gibson's notion of invariance and something to the Gestalt theory. Gibson (1950, 1968) argued that in the stimulus array there are permanent or unchanging features which reveal the invariant structure of the environment. There is, to use Ruff's (in press) terms, invariance or nonchange to specify the arrangement of objects in the entire environment, invariance to specify the structure of individual objects, and invariance to specify the structure of the finest texture. Even though an object moves, changes in orientation or size or in shape through plastic deformations, there are nevertheless certain structural fixities that continue to specify the object.

I want to propose to you that these permanencies or invariances that Gibson (1950, 1968) and, more recently, Ruff (in press) in her excellent review, see as the basis of recognition--or, if you like, as the basis of early meaning--are unchanging relationships; not features in the absolute sense, but relationships between them. It seems to me that Schwartz's (see Schwartz & Day, 1979) extensive investigation of the perception of figures by infants as young as eight weeks has shown that the spatial relationships between lines that make up angles and figures is the critical invariance for shape perception. The figure can be rotated or inverted but, providing these angle and figure relationships hold, the figure is recognised. Even though the outline of the figure is incomplete--lacking in the corner angles or bits of its contours--it is still recognised. Likewise, as we know, information for distance is necessary for perceived constancy of object size and information for slant for perceived constancy of shape. It is reasonable to assume that the basis of visual size and shape constancy during early infancy is determined by the invariant relationship between retinal size and distance information and between retinal shape and slant information. The role of such information is well established for adults.

Position constancy, as we have noted, occurs substantially later in development--possibly sometime quite early in the second year. The unchanging relationship that uniquely defines the object's position can be taken to be that between the object and the space in which it lies; for example, its relationship to a wall, a table and a desk.

What is so impressive about infant perception is that this fixed relational information can be "extracted"--if I may use that term--even when the overall situation has undergone a considerable change. Thus Burnham's (Burnham & Day, 1979; Day & Burnham, in press) experiments have demonstrated that the colour-shape characteristics of rotating crosses and those of laterally moving objects are extracted and serve as a basis of identification when the object changes from being stationary to moving to being stationary.

Similarly Amanda Norman has shown that the relationships in three-dimensional objects such as open cylinders and triangles are extracted and used as the basis of recognising two-dimensional representations--that is, in recognising pictures of objects.

In summary, I propose that recognition and identification of objects and events by young babies turns primarily on invariant relationships and that these uniquely defining relationships are extracted over a wide range of changes in the total situation.

In conclusion, I wish to make two further generalisations. Firstly, it seems to me that in early infancy these relationships must derive from sensory-neural processes and automatic storage. Perceptual capacities occurring so early in life can reasonably be regarded as having their basis in such interactions and storage without the operation of higher-level cognition. Even though size and shape constancy might seem to imply a higher level of activity than simple form perception I believe that they derive from quite basic or primitive processes--not cognitive processes in which distance and slant are "taken into account". If you doubt this may I draw your attention to the experiments of Ewert and Burghagen (1979) and of Ingle (1968) which show that toads and frogs, organisms not normally associated with higher cognitive functioning, have well developed size constancy. This suggests that the processes involved are pretty fundamental. Later in development it seems that higher level processes mediate in the extraction of relationships. Recall that whereas size and shape constancy are operating well within the first half-year position constancy, according to our observations, emerges much later. In short, it seems that whereas some relations define forms and properties in an entirely mechanistic fashion others derive from cognition as we know it in adulthood.

Finally, if there are doubts about the potency of relationships in the perception of form it is only necessary to refer to the fascinating and important observations of Gunnar Johannson at Uppsala. Johannson (1977) attached lights to a person walking or to two people dancing. The lights were attached at the main points of articulation--the ankles, knees, hips, wrists, elbows and shoulders. While the figures are stationary all one sees is a constellation of scattered lights with no defined form or shape. When they walk or dance together the scatter resolves itself into a clearly recognisable event. We have recently confirmed these observations. The event is recognisable, of course, from the preservation of the motion relationship between the points. There is no *visible* head, shoulders, hands, or any other parts, only the relative motions of the moving points. It is an example par excellence of the potency of invariant relationships in perception.

I should say that Heather Hodgson working this year in our laboratory has shown that 3-year-old children are able readily to recognise an individual walking in one of these displays. They cannot, however, distinguish between their mother and a stranger walking. Adults sometimes can.

It would be of considerable interest--and, I believe, an important datum--to establish whether infants are capable of recognising events (as contrasted with objects and things) using the sorts of moving-point displays I have shown you. It would be a relatively simple procedure to show the baby an actual event and then a moving-point version of it. My intuition is that 4 to 6-month-old babies would be able to extract the invariant relationship in a simple event and then recognise it in the reduced relational form.

Acknowledgements

The author acknowledges the contributions to the research reported in this paper made by Dr. B.E. McKenzie, La Trobe University, Dr. Marcelle Schwartz, The Lincoln Institute of Health Sciences, and Mr. D.K. Burnham, Mrs. Amanda Norman and Mrs. Heather Hodgson of the Infant Behaviour Group at Monash University. The support provided by the Australian Research Grants Committee to Dr. B.E. McKenzie and the author is also gratefully acknowledged.

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OBJECTS - HOW DO PIAGETIANS, GIBSONIANS, AND INFANTS SEE THEM?

Denis K. Burnham
Monash University

For the mature adult, an object is unique and permanent and exists in space independent of observers or other objects. Two aspects of this object concept can be distinguished--identity constancy and existence constancy. Identity constancy concerns the uniqueness of objects and can be defined as the tendency to conceptualise an object as being the same object despite variations in position, time of presentation, orientation, trajectory or velocity. Existence constancy concerns the permanence of objects and can be defined as the tendency to perceive or conceptualise the continued existence of an object despite its diminished or discontinued sensory representation.

The object concept develops both over phylogeny (Flavell, 1977) and ontogeny (Piaget, 1954) and this paper concerns some aspects of its ontogenic development in human infants. In the first part, Piaget's and Gibson's theoretical approaches to object concept development are described and compared. In the second part empirical evidence is reviewed and some points of interest are discussed regarding the main disagreement between the two approaches--the role of perception in the development of the object concept.

I. Theories of Object Concept Development

The Piagetian Approach: Construction of the Object. Piaget's view of the origins of knowledge is similar to the Rational epistemology: knowledge of the world is constructed out of the child's operative interaction with the world. For Piaget, true knowledge of objects, is knowledge of the transformations which they can undergo and the operations which can be performed on them, and this knowledge can only be derived by actual operative interactions with objects. The nature of operative interaction with the world changes over development: in the sensori-motor period, which is of concern here (birth to 18 months or so), operative interaction is by actual motor actions upon objects. Knowledge of objects cannot derive from figurative activities alone, for example, from perception, imaging, or imitation. These figurative activities give rise to knowledge only insofar as the child has a framework of operatively-formed structures through which this figurative experience can be interpreted (Piaget, 1969; Furth, 1969). However, the very young infant, who does not yet reach for and grasp objects, does not have such a framework of operatively-formed structures. So he cannot interpret the constant flux of stimulation in terms of permanent and unique objects. Therefore he lives in a very egocentric world, a world in which objects, the child's perceptual schemata and the child himself are not differentiated; and a world in which perceptions of objects from separate modalities are not integrated. Thus, it is only with the emergence of prehensile actions upon objects around 20 weeks of age that the object concept can even *begin* to develop (Piaget, 1954). Gradually the child begins to abstract the notion of permanent objects from out of his motor activities with them, and gradually perceptual schemata from different modalities begin to become integrated enough to specify the same object.

The Gibsonian Approach: Direct Perception of Objects. Gibson's view of the origins of knowledge is similar to the Empirical epistemology: knowledge comes through experience, not reason, and reality is fixed and prior to experience. All information is "out there" and the task of the organism is to "pick up" the structure of this information. Improved information pick up comes about by perceptual learning and development, which involves two aspects--the detection of invariances of stimulation despite various transformations, and the differentiation of more and finer properties in the perceptual array (E.J. Gibson, 1969; J.J. Gibson, 1966). Development of the object concept involves picking up those object properties which remain invariant over time (Gibson, 1969).

T.G.R. Bower is the main proponent of the Gibsonian approach to object concept development. He picks up the Gibsons' notion of differentiation and differentiates various ways in which differentiation occurs in development. One form is the differentiation into modality-specific perceptions of initially amodal or nonsensory perceptions (Bower, 1978), and this underlies Bower's claim for intersensory substitutability at birth, with information from different senses slowly becoming differentiated over development. Another form of differentiation is the differentiation of more and finer aspects of the perceptual array, and this underlies Bower's claim that the information processing capacity of the perceptual systems is restricted in early infancy and improves over development. This limited processing capacity, coupled with inadequate differentiation of the perceptual system, results in selective perception of the most informative aspects of the perceptual array. These are the invariants provided by the dynamic relational aspects of stimulation (Bower, 1978). This selective perception of movement, patterns of change, and the relations between objects, enables infants of a very young age (3 weeks) to pick up the information for existence constancy contained in clear cases of disappearance, for example, kinetic occlusion sequences (Bower, 1967; Bower, Broughton & Moore, 1971). But this selective perception also results in an immature definition of the identity of an object as a bounded volume of space at a certain place, or on a certain path of movement. By about 20 weeks, differentiation of the perceptual array coupled with the increased processing capacity of the perceptual systems, results in the features of objects now being included in the definition of identity (Bower, 1974; Bower et al., 1971).

Summary and Comparison of Theories

Piaget holds that knowledge of objects and the transformations they can undergo, can only be based on the child's actual operative interactions with objects. While Bower agrees that knowledge of objects is knowledge of their transformations, he holds that such knowledge can derive directly from figurative perception. For Piaget, the newborn's perceptual schemata from different modalities are not well integrated and elements of schemata are not differentiated. Development from this egocentric world involves the integration between and differentiation within schemata. For Bower, information from newborns' different sense modalities is intersubstitutable but their information processing is limited and this results in newborns' selective perception of the higher-order relationships between objects. Development from this selectively perceived world involves differentiation of the perceptual systems and of the perceptual array. Thus Piaget's infants have to construct the object concept from out of their motor interactions with the world, while Bower's infants come readily equipped to selectively perceive those higher-order aspects of the world which specify permanent objects. So, while Piaget's newborn has no notion of the concept of objects, Bower's newborn exhibits existence constancy in simple cases of disappearance, and a rudimentary form of identity constancy, which does not take the features of objects into account.

There is one similarity between the theories: in both, a significant change in behaviour occurs around 20 weeks. For Piaget, the onset of prehension enables the object concept to begin to develop around 20 weeks, while for Bower, around 20 weeks the concept of identity constancy becomes more mature because infants begin to incorporate object features into their definition of objects.

II. Perception and Knowledge: Empirical Review and Discussion

The most important point to arise from the above review is the contrast between the Piagetian position that knowledge can only arise from operations on the world, and the Gibsonian position that knowledge of the world can arise directly from perception. The contrast between these two positions can be translated into the following research question, "Can infants gain knowledge of the object concept by perception alone without the aid of prehension, that is, do infants below 20 weeks have knowledge of the object concept?"

The first experiments which investigated the object concept with infants below 20 weeks were done by Bower (1966, 1967). Results of these suggested that 3-to 18-week-old infants displayed some degree of existence and identity constancy for stationary objects. However Piaget has pointed out (in Bower et al., 1971) that these experiments with stationary objects did not allow conclusions about infants' operative knowledge of the world. To counter this criticism Bower did a number of experiments in which infants observed events involving laterally moving objects (Bower et al., 1971; Bower & Paterson, 1973). It was reasoned that the perception of events in these experiments rather than of static displays in the previous experiments, would entail perception of objects per se, rather than of their figurative properties alone. The events involved such trick situations as laterally moving objects changing features or trajectory behind an occluding screen, and objects moving laterally to unexpected locations. The main dependent variables were infants' valid and invalid anticipatory tracking, and disruption of their anticipatory tracking. Results of these experiments gave rise to Bower's conclusions about existence and identity constancy in infants below 20 weeks, namely that existence constancy held in simple cases, but that infants' knowledge of object identity was limited.

Bower's use of anticipatory tracking and disruption of tracking to index aspects of the object concept can be criticised on a number of grounds (Burnham, 1980). One particularly damaging criticism is that the determinants and the meaning of disrupted and undisrupted tracking responses are not clear. In this regard, Muller and Aslin (1978) found, in contrast to Bower, that tracking was not disrupted when the features of objects changed behind an occluding screen, and that tracking disruption was dependent upon other factors: disruption occurred more with larger screens, with slower moving objects, and with the combination of these two, longer occlusion times. Experiments by Goldberg (1976) and Meicler (1977) also found no changes in infants' visual fixation or tracking behaviour, when features of objects were altered behind an occluding screen. Moreover, heart rate and affective scores were used as subsidiary measures in these two experiments respectively, and these indicated that infants noticed the feature changes of the briefly occluded moving objects. Together, these three studies strongly suggest that visual tracking is not a good index to use when investigating the object concept, because it is not sensitive to feature changes of briefly occluded objects, even when independent measures show that infants have actually noticed such changes. Therefore no firm conclusions can be drawn from Bower's experiments, and the point of disagreement between the Piagetians and Gibsonians--whether infants younger than 20 weeks can derive knowledge of objects from perception alone--remains unresolved.

One problem with Bower's experiments may have been that he tried to place an over-sophisticated interpretation on infants' tracking, disruption of tracking, and anticipatory tracking responses. A better approach to the problem of object concept development has been used in recent experiments, which have investigated whether infants can recognise an object as the same object, despite physical transformations of the object, that is, whether identity constancy is maintained over transformations. In these experiments, infants were habituated or trained with a certain stimulus and then tested for recognition of this now familiar stimulus when it, and a novel stimulus, moved in a discriminably different manner. The general paradigm is shown in Figure 1.

This approach has three advantages over Bower's approach. First, as the influence of perception on object concept development is being studied, it makes sense to investigate whether stimulus attributes which young infants are known to perceive, for example, colour, shape, or pattern, contribute to infants' definition of object identity. Second, by shifting the emphasis from existence constancy to identity constancy,

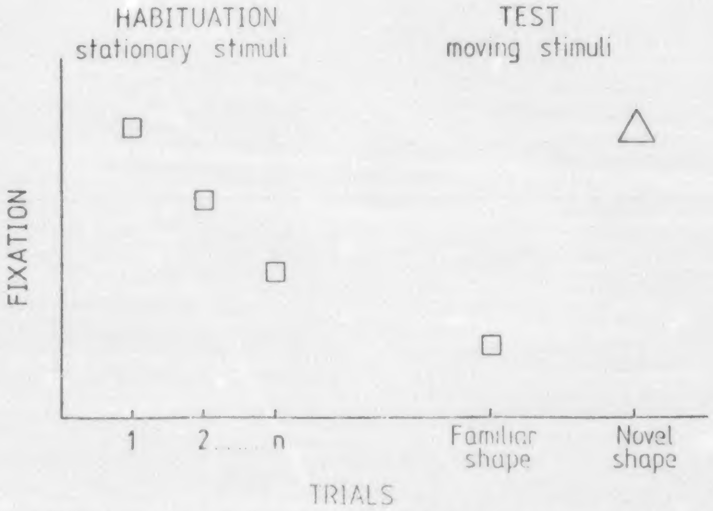


Figure 1. Paradigm of Motion Transformation Experiments

experimenters can simply record infants' responses to objects which are present, rather than having to devise measures which are meant to indicate infants' reactions to objects which are absent. Finally, this approach takes advantage of a well known effect, namely infants' preference for novel objects.

This transformation paradigm has been used in operant conditioning experiments by Hartlep and Forsyth (1977), and in habituation experiments by Burnham (Burnham, 1980; Burnham & Day, 1979; Day & Burnham, in press) and also by Eleanor Gibson (Gibson, Owsley, Walker & Megaw-Nyce, 1979). In all of these experiments infants of less than 20 weeks of age recognised the familiar object and discriminated between this familar object and the novel object, despite the fact that the familiar object was now undergoing a discriminably new motion transformation.

Two conclusions can be drawn from these experiments. First, contrary to the Piagetian position, infants can recognise objects by their features, before they engage in any extensive operations upon them, that is, infants recognise objects on the basis of perceptual information alone. The possible Piagetian objection that infants recognise some previous reaction or looking schema containing the object (Piaget, 1954) is not valid because objects were recognised even when they were moving differently and thus "part of" a new looking schema. The second conclusion is that Bower's speculation about young infants' limited definition of identity is incorrect, because the experiments show that objects are defined in terms of their features, by infants below 20 weeks of age. Nevertheless, these demonstrations of identity constancy imply that the concept of an object is beginning to develop very early in infancy, and therefore support the general Gibsonian flavour of Bower's theory.

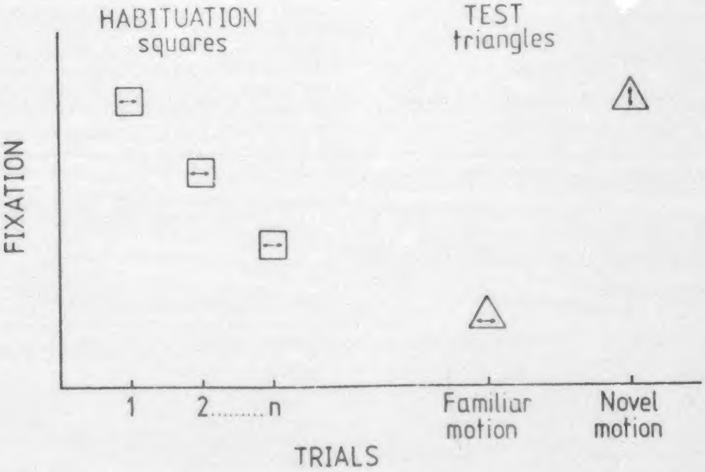
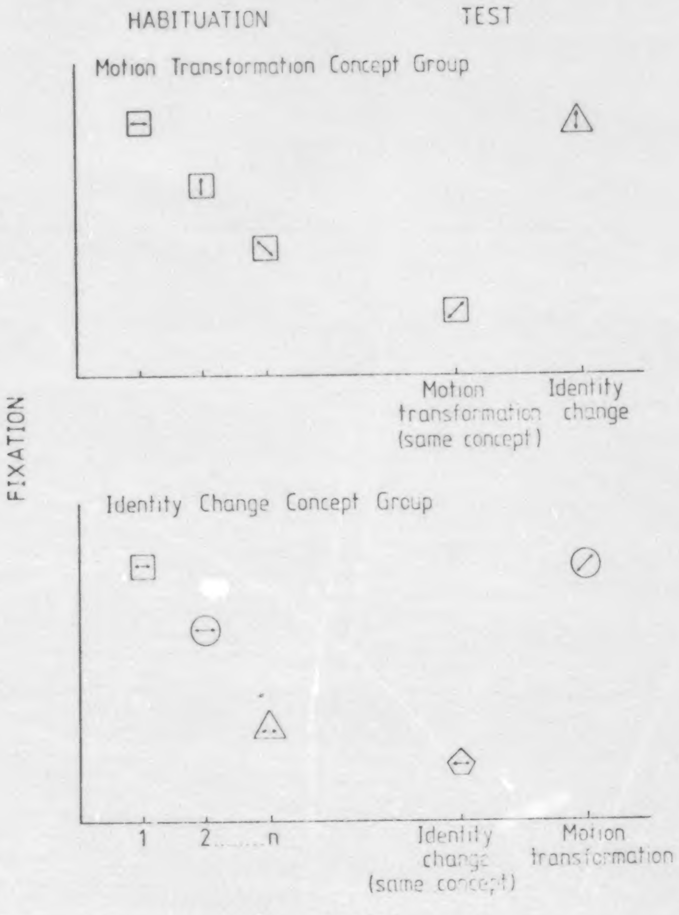


Figure 2. Possible Paradigm for Identity Change Experiments

A problem remains: it cannot be firmly concluded from these experiments that young infants define objects only by their features. Similar, but inverse results may obtain in the possible experiment shown in Figure 2, where infants are habituated to an object undergoing a transformation, for example, a square rotating about its vertical axis, and then tested with two objects with changed identity, for example, two triangles, one undergoing the now familiar transformation and one undergoing a novel transformation, for example, rotation about the horizontal axis. On the same reasoning as in the experiments reported above, recognition of the familiar transformation and recovery to the novel one could be taken to mean that infants believe objects to be defined by their particular transformation, despite feature changes.

To overcome this criticism, experiments need to be devised whereby it can be determined whether an object's features are more integral to its identity than its possible transformations. A possible way of testing this could involve the method introduced by McGurk (1972) whereby infants are habituated to a class of stimuli, varying on a particular dimension. Test trials involve a change in the same dimension which varied in habituation trials or in a dimension kept constant in habituation trials. If infants have formed a concept of the class of habituation stimuli, then recovery of fixation should be greatest when a change occurs in the dimension not varied in habituation. A paradigm to investigate the basis of identity constancy using this detection of invariance method is shown in Figure 3. Two groups could be tested-one for which a single identical object undergoes various motion transformations in habituation, and another for which a number of objects are presented in habituation, all undergoing the same motion transformation. If features are more "part of" the object than motion transformations, then it should be easier for infants to form a concept of a single object undergoing a number of motion transformations (Figure 3, motion transformation group), than a concept of a single transformation undergoing a number of identity changes (Figure 3, identity change group). That is, the degree of recovery to the identity change in the motion transformation group should be greater than the degree of recovery to the motion transformation in the identity change group. A design such as this could be used to pair different identity changes, for example, shape, colour, and pattern, with different transformations, for example, orientation, motion, and position. Such experiments could ascertain whether infants saw identity to be a more integral part of the object than its possible transformations.

In summary, there is some evidence to suggest that infants below 20 weeks retain identity constancy for objects despite object transformation, that is, that operative knowledge of objects is obtained via perceptions. This evidence generally supports the Gibsonian rather than the Piagetian position. It can also be concluded from these studies that the identity of an object is based on its features, which does not support Bower's modification of the Gibsonian position. However, although these studies show that infants base object identity on object features, the studies do not show the extent to which this occurs: it cannot be ascertained whether the concept that infants have of identity, depends on features alone or whether other incidental aspects--position, orientation, or motion--are also included in object identity. The results of the experiment which has been suggested should clarify this


HABITUATION
TEST
Motion Transformation Concept Group
Motion transformation (same concept)
Identity change
FIXATION
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Identity change (same concept)
Motion transformation
TRIALS

Figure 3. Possible Paradigm for Motion Transformation versus Identity Change Experiments

aspect of the development of the object concept.

There is one final point of interest: you may have noticed that it has been implicitly assumed that the results of these experiments imply that the infant recognises the familiar object as exactly the same object. Of course, this can never be definitely concluded from these methods, and we can only really conclude that the infant sees some similarity between two presentations of an object. This limitation should not be allowed to restrict investigation of the infants' object concept, especially when two aspects of adult behaviour are considered. First, it is sometimes difficult for an adult to specify that an object is exactly identical to one seen previously. For example, positive identification may occur for well known faces but for a class of objects which are similar, such as a set of wine glasses, positive identification may not be possible, at least without information over and above purely perceptual information. Second, even mature adults may not necessarily have a fully mature object concept. Certain experimental findings suggest that objects are not necessarily seen as entirely independent entities, for example, context effects in memory and field effects in perception, such as the rod and frame effect and induced movement. Thus the definition of the mature object concept is not as simple as that given at the beginning of this paper, which points to the need for parallel research on the adult object concept. For example, it would be interesting to ascertain whether adults consider the possible motion transformations of an object, such as its ability to bend, bounce, walk, or sway in the wind, to be integral to the object's identity.

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INFANTS' RESPONSES TO MISMATCHED SENSORY INFORMATION DURING MOTHER-INFANT INTERACTION.

Jack Broerse
Mt. Gravatt College of Advanced Education

Carol Peltola and Boris Crassini
University of Queensland

The perceptual unity hypothesis of infant perception (see E.J. Gibson, 1969; J.J. Gibson, 1966) is that sensory information specifying one aspect of an object or an event will elicit behaviour consistent with the expectation of other forms of sensory information. For example, visual stimuli elicit reaching (Field, 1977), and auditory stimuli elicit looking (Crassini & Broerse, 1980). A test of the perceptual unity hypothesis has its origins in the ongoing popularity of magic and ventriloquism as forms of entertainment. In both cases, expectations are violated (rabbits appear out of hats and disappear into thin air; human voices appear to come from inanimate objects) producing reactions of surprise, and even fear. It has been reported that young infants exhibit similar affective responses when confronted with what may be termed perceptual paradoxes based on mismatched sensory input. For example, Bower, Broughton, and Moore (1970) presented young infants with either a real object or the virtual image of an object (in both cases, within arm's reach). They reported that infants who failed to obtain appropriate tactile stimulation after reaching for the visually specified target reacted with "frustration and tears" (p. 52). Aronson and Rosenbloom (1971) used a similar paradigm to look for changes in affective behaviour that might be associated with auditory-visual paradox. They reported that infants became distressed when their mothers' voice was artificially displaced from the spatial location of her face.

This pattern of results is disturbed somewhat by a number of failures to replicate the influence of perceptual paradox on infants' affective behaviour (e.g., Condry, Haltom, & Neisser, 1977; Field, 1977; McGurk & Lewis, 1974). Of the several explanations that may underlie these failures to replicate, the possibility that infants in fact do not demonstrate perceptual unity is unlikely. Not only are there a large number of supporting data from other paradigms, but even the results of the studies in question support the perceptual unity notion. For example, Field (1977) reported that infants did reach towards both real and virtual stimuli, and McGurk and Lewis' (1974) infants did turn towards mother's displaced voice. It may be, then, that the problem is the selection of suitable dependent variables, with affective behaviour being, as suggested by Condry et al. (1977), an inappropriate tool with which to study infant perceptual processing. The purpose of the present study was to investigate this issue.

Rather than selecting on a priori grounds a particular component of infant behaviour and attempting to equate this with infant affective state in general (cf. Aronson & Rosenbloom's (1971) use of tongue protrusions as a state measure), we decided to adopt a global rating of infant state. Furthermore, we decided to use a seven-point scale of affective reaction in an attempt to improve on the sensitivity of the three-point scale used unsuccessfully by Condry et al. (1977). An additional consideration in the present study was the avoidance of "conflict" between affective and exploratory responses inherent in the studies of Aronson and Rosenbloom (1971), Condry et al. (1977), and McGurk and Lewis (1974). In their experiments, separate sources of sensory information were spatially separated thereby encouraging search/orientation responses which could inhibit the occurrence of affective responses. Casual observation of infant-caretaker behaviour lends support to this interpretation: An often used (and successful) ploy to minimise infant distress is to distract the infant by redirecting attention away from the source of distress to some novel stimulus. Thus, in the present experiment, the spatial location of mother's voice and face were altered minimally. Perceptual paradox was produced by removing a component (either visual or auditory) of the sensory information available during normal mother-infant interaction, and the effect of this removal on infant state was measured.

Method

Subjects. Twenty-three female and 14 male infants and their mothers participated. Mean age of the infants was 12.8 weeks, with a range of five weeks. All were normal full-term babies with no history of severe illness or trauma at or after birth.

Apparatus. Infants were tested in a modified Maico Audiometric Enclosure (Model 250) situated in a sound attenuated observation room. A Safe-n-Sound infant car-seat was mounted on a platform 69cm from the base of the enclosure. The car-seat was tilted at 30 deg from vertical and when in position the infant's face was approximately 40cm from a double glazed window which enabled mother and infant to engage in unrestricted mutual gaze. The window also allowed the infant to be videorecorded during the entire interaction. Illumination levels inside and outside the enclosure were preset to enable clear visibility yet avoid excessive reflection during experimental trials requiring the elimination of external illumination (see below).

The mother sat directly opposite the infant with her face about 20cm away from the window. She wore two microphones, one relaying her voice into the enclosure (on those trials when infants were to hear their mother's voice, see below), the other enabling her voice to be recorded onto a videorecording. The mother's voice was presented to the infant at normal conversational intensity through a loudspeaker mounted directly above the window in line with mother and infant. A third microphone was mounted inside the enclosure so that the infant's vocalisations could also be recorded. The experimenter (from an adjacent room) was able to control the lighting so that during certain conditions the mother was not visible to the infant while the infant remained clearly visible to the mother. A digital clock was used to time presentation of experimental conditions and the clock was superimposed onto the videorecord of the interaction for use in later scoring.

Procedure. Each mother was instructed to interact verbally (as normally as possible) with her infant for a period of about seven minutes while the infant was videorecorded. The mother was asked to ignore any changes in illumination that might occur from time to time, and to avoid comment upon such changes in her "conversation" with the infant. In this way, the videorecord contained no verbal cues as to the nature of the particular experimental condition being used. The infant was placed in the car-seat by the mother and the door of the enclosure was left slightly ajar while the infant became familiar with the novel surroundings. After two or three minutes the door to the enclosure was gently shut and the experiment began.

Interactions were observed under three experimental conditions, these being: (a) correlated auditory and visual information (A+V) where the infant could both see and hear its mother, (b) sensory information restricted to the visual modality (V) where the infant could only see its mother, and (c) sensory information restricted to the auditory modality (A) where the infant could only hear its mother (see Note 1). Each mother-infant interaction began with a one minute baseline period of the A+V condition. The remaining six minutes consisted of alternate one minute presentations of 2 of the 3 experimental conditions. Counterbalancing resulted in six experimental groups (see Table 1) to which mother and infant pairs were randomly allocated.

Table 1

Order of Presentation of Experimental Conditions and the Number of Infants in each of the Six Experimental Groups

		Experimental Conditions in Each 1-minute Period of Interaction						
Experimental Group	No. of Ss	Base-line	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7
1a	5	A+V	A+V	V	A+V	V	A+V	V
1b	6	A+V	V	A+V	V	A+V	V	A+V
2a	6	A+V	A+V	A	A+V	A	A+V	A
2b	5	A+V	A	A+V	A	A+V	A	A+V
3a	5	A+V	V	A	V	A	V	A
3b	6	A+V	A	V	A	V	A	V

An undergraduate student was paid to act as a judge of infant affective state from the videorecordings of the interactions. Affective state was rated on a seven-point scale: from +3 (very contented) through 0 (neutral) to -3 (very distressed). Judgments were made on successive 10 sec intervals of the videorecord. Each mother-infant interaction was scored twice over a period of three weeks.

Results

Ratings were averaged to give a single value for each minute of interaction. Baseline A+V ratings were then subtracted so that all subsequent scores represent changes from baseline. Data from experimental groups receiving the same experimental conditions in counterbalanced order were collapsed to produce a between-subjects factor for analysis of variance. This was Factor A, Experimental Group (three levels: Group 1, A+V vs V; Group 2, A+V vs A; Group 3, V vs A). Two within-subject factors were also used, namely Factor B, Ordinal Position Within the Experimental Condition Pair (two levels: first experimental condition for each group; second experimental condition for each group), and Factor C, Temporal Position of Experimental Condition During the

Interaction (three levels: first presentation, minute 2/3; second presentation, minute 4/5; third presentation, minute 6/7).

The analysis of variance revealed significant main effects for Factors B ($\underline{F}(1,30) = 13.6$, $\underline{p} < .01$) and C ($\underline{F}(2,60) = 4.3$, $\underline{p} < .05$) with no other significant main effects or interactions. The mean change in affective state for the first, second, and third presentations of the experimental conditions (i.e., Factor C), were -0.5, -0.8, and -1.1 respectively, reflecting a progressive increase in infant distress over time. Figure 1 presents the mean change scores in affective state for the three experimental conditions as a function of the number of presentations of each condition. Planned comparisons indicated that infants were more distressed during input from a single modality than when sensory input was correlated ($\underline{F}(1,60) = 5.2$, $\underline{p} < .05$).

Discussion

Although mothers and infants were interacting in an artificial setting, infants' affective state during baseline A+V conditions was judged to be relatively neutral on a seven-point rating scale. When one source of sensory information was removed however, there was a clear deterioration of infant state (see Figure 1). These data can be interpreted as showing that infants "expect" certain correlations between properties of objects and events in the external world. When such correlations are not forthcoming, infants display a change in affective state. However, there was some indication (Figure 1) that although infants' behaviour was clearly influenced by the nature of sensory information available during interactions with their mothers, loss of visual input did not seem to produce equivalent affective changes to loss of auditory input. Since the differences in ratings between A and V conditions only approached statistical significance, this interpretation is made guardedly. There are, nevertheless, similar reports of such modality differences from other paradigms. Field, DiFranco, Dodwell and Muir (1979), for example, found that infants were both slower and less likely to orient to auditory stimuli than to visual stimuli.

Two other aspects of the data warrant discussion. The first concerns the general tendency for the affective state in all experimental conditions to steadily worsen with repeated presentations. This finding supports McGurk and Lewis' (1974) criticism of Aronson and Rosenbloom (1971) who failed to counterbalance the order of presentation of bimodally correlated and uncorrelated sensory input. Unexpectedly, the rate of decline in state during A+V sensory input in the present study was similar to that during A and V conditions (see Figure 1). It is clear that the alternating periods of correlated A+V input were insufficient to counter the negative effects of unimodal input. However, judgments of infant state during correlated sensory input were never as negative as during unimodal input, even after three A+V presentations.

The second concerns the use of affective responses in infant research. Condry et al. (1977) concluded that affective and exploratory responses were qualitatively different with respect to their utility as dependent variables in investigations of infant perception. Rather than reinforcing this apparent cleavage between the two types of

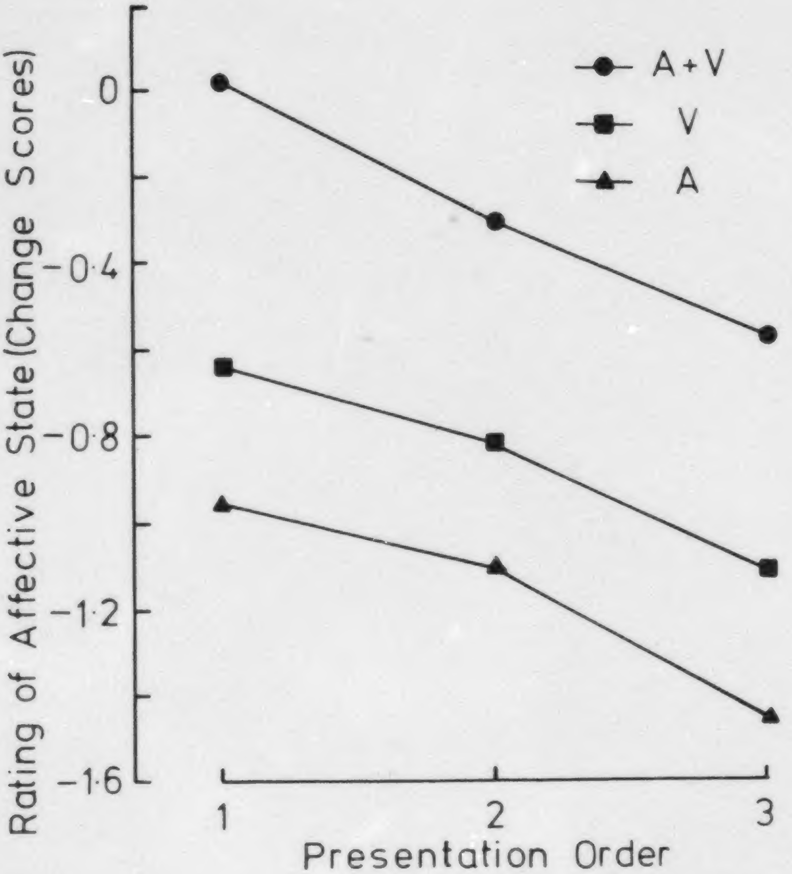

Figure 1 Ratings of affective state (change scores from baseline) for the experimental conditions as a function of presentation order

responses, our data support a more parsimonious conclusion. That is, given an adequately sensitive index of infant state, affective behaviour can be used to study infant perceptual processing thereby providing a further tool at the experimenter's disposal.

Notes

1. During conditions where the infant could hear, but not see its mother, the ambient illumination was also absent. To determine whether any state differences could be attributed to this absence per se, an ad hoc control group was tested. Four subjects were run in a condition in which during the first A period following the baseline condition, the mother moved away from the window. In this way ambient illumination could be restored yet the mother remain "invisible". The number and duration of these alternative light and dark periods were identical to those used in the main study. The results indicated that loss of ambient illumination per se was not responsible for the changes in affective state reported in the A condition.

2. This research was supported by grant No. A78/15622 from the Australian Research Grants Committee. Our thanks to the mothers and infants who took part, and for the cooperation of Dr. E.J. Esler, Medical Superintendent, Mater Misericordiae Mothers' Hospital. The support of the Centre for Human Development Studies at Mr. Gravatt CAE is gratefully acknowledged, as is the assistance of the staff of the Department of Psychology, Penn State University in the preparation of this manuscript while the third author was on Special Studies Program Leave. Special thanks also to Robert O'Shea.

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LOOKING AND LISTENING IN THE FIRST YEAR OF INFANCY

Jeff Field
University of Western Australia

As adults we often integrate multimodal sensory information about an event in order to derive a more efficient perceptual experience of it. Such intersensory integration involves both the detection and anticipation of spatio-temporal correspondences between sensory inputs. In this paper I will discuss specifically research on the development of integration between the auditory and visual systems of young infants.

Theoretical viewpoints on the development of auditory-visual integration range from the suggestion by Bower (1974) that the infant's perceptual systems are functionally unified at birth, to the position of Piaget (1953), who maintains that infants' looking and listening are initially uncoordinated activities, which begin to be integrated from about the third month after birth. Evidence relating to these theoretical propositions comes from two broad areas of research: studies of auditory localisation responses and the experimental manipulations of events that are specified bimodally under normal circumstances. I will be discussing only research on auditory localisation in this paper.

In recent years there has been an accumulation of experimental evidence that healthy newborn infants will turn their heads toward moderately loud rattle sounds (Clifton, Morrongiello, Kulig & Dowd, 1980; Muir & Field, 1979) and human speech (Alegria & Noirot, 1978; Turner & MacFarlane, 1978). The newborn localisation response typically has a long latency of around five seconds and the turn is also slow, requiring several seconds for completion. Successful elicitation of the newborn head-turn response is dependent upon arousing subjects to a quiet, alert state. A more important difficulty, from the viewpoint of those wishing to screen for newborn hearing loss, is that individual differences in the reliability of auditory localisation responses are quite marked.

Despite the evidence for spatiotemporally related listening and looking behaviour in newborns, it still seems unreasonable to conclude that auditory-visual integration is present from birth. Although newborns turn and look at sound loci, we still have no evidence that their looking is anticipatory or intentional. This probable lack of intentionality in the auditory localisation responses of very young infants seems to be reflected in the difficulty of demonstrating habituation and conditioning of their head-turn responses. In a study reported since the completion of the work described in this paper, Clifton et al. (1980) found no habituation of head turning at birth or at 2 months of age. Moore, Wilson and Thompson (1977) also found that, while they could not maintain a left head-turn response to a sound in 4-month-old infants by the use of a visual reward system, they had no difficulty maintaining the headturning of infants over 5 months of age.

Although we have some evidence that truly integrated listening and looking is occurring around 5 months of age, there does not seem to be any systematic data on the individual consistency of headturning responses to sound at that age. The availability of individually reliable, easily measured responses is a crucial concern for clinicians involved in screening for hearing loss in young infants (Wilson, 1978). The two experiments reported in this paper were designed to assess the individual consistency of auditory localisation responses in 5-month-old infants and to increase our understanding of such infants' ability to learn spatiotemporal associations between sounds and sights.

Experiment 1

If 5-month-old infants look toward a sound source with the expectancy of seeing something at its location, then they should show habituation of such an orientation response when there is no salient visual consequence at the sound locus. Therefore, in the first experiment, while half the 5-month-old subjects saw a dramatic moving puppet after turning toward a sound, the other half only saw a grey-surfaced speaker. All the 16 infants in the study (mean age = 153 days) were tested in a U-shaped screen enclosure with two 6-inch speakers placed 45° to the left and right of the subject's midline, and at a distance of 45cm from the subject's head. The speakers were covered with grey cloth and their grey surfaces could be seen behind two holes cut for them in the U-shaped screen. Each infant was strapped into a slightly reclining seat and faced toward a central aperture in the screen.

On each of 16 trials, the infants first had their attention drawn to a bullseye pattern presented in the centering aperture. When the centering stimulus was being fixated the test sound was presented randomly through either the left or right speaker. The centering stimulus was removed within 1 second of the sound onset. The signal was a tape recording of a phasic rattle sound produced by shaking a plastic medicine bottle half-filled with popcorn kernels. At the infant's head position the signal had an average peak intensity of 70 dB SPL. The rattle sound was presented continuously until the subject made a lateral head or eye turn of 45°. Responses were recorded and monitored via a TV camera placed above and behind the centering aperture.

For the eight subjects in the visual consequence condition initial 45° turns toward the correct speaker were rewarded with an immediate presentation of a handheld puppet in front of the appropriate speaker for 5 seconds. An incorrect, initial, 45° turn led to the cessation of the sound and an intertrial interval of 5 seconds before the subject was recentred. The initial 45° turns of the eight subjects in the no consequence condition were treated in the same manner as incorrect turns for the visual consequence group.

The numbers of correct turns for the subjects in each condition are given in Table 1. There was no significant difference in the performance of the two groups. The number of correct initial 45° turns did not differ significantly. Analyses of performance across trials also failed to reveal any evidence of habituation, which could have been reflected in either a decline in the accuracy of turns, or an increase in their latency.

Table 1

Number of Correct, Initial, 45^{0} Turns to Rattle Sounds (70 dB SPL) by 5-month-old Infants over 16 Trials

Visual Consequence	No Consequence
16	13
16	13
13	14
16	15
16	16
11	15
16	7
16	16

The finding of no decline in performance across trials in the "no consequence" group deserves some comment. It seems unlikely that the sight of plain grey speakers served to maintain the turning response of these infants. Rather, it is possible that the regular appearance of the centering stimulus 5 seconds after subjects completed a 45^{0} turn may have provided a delayed reward for head turning. It is also possible that the spatial complexity provided in the task by the random left/right presentation of sounds may have reduced the likelihood of habituation of the orientation response for such young infants. Certainly these findings raise questions about the capacity of 5-month-old infants to learn spatiotemporal associations between sounds and sights. Nevertheless, one clear outcome was the indication that 5-month-old infants can show highly consistent auditory localisation responses on an individual basis, over many trials, without obvious changes due to learning or habituation.

Experiment 2

If 5-month-old infants make individually reliable responses to moderately loud sounds in the bilateral test situation, do they also respond reliably to sound levels approximating those used to screen for mild and moderate hearing loss? We know that infants 6 months and older can yield group detection thresholds of around 25 dB SPL for speech range signals (Trehub, Schneider & Endman, 1980) and that conditioning procedures can also be used with infants over 6 months for threshold assessments (Wilson, 1978), however, reliable screening of younger infants remains a problem. The second experiment therefore compared the auditory localisation responsiveness of 5- and 7-month-old infants to sound stimuli presented in a quiet room at intensity levels approximating those of soft speech.

Eleven 5-month-old (mean age = 150 days) and nine 7-month-old (mean age = 207 days) infants were tested in a situation very similar to that of the previous experiment. No subjects had to be rejected for fussiness. All the 7-month-old infants and about half of the younger subjects were tested while seated on their mothers' laps. In such cases the mothers always wore headphones over which masking noise was presented to prevent them detecting the side of presentation of the auditory signal on each trial.

The infants were again faced toward the centering aperture of a brown, U-shaped screen, which had speakers placed in the same 45° positions as in Experiment 1. Correct turns toward the same rattle sound were immediately rewarded with a moving puppet on all trials. After incorrect responses the sound was turned off and the subject was recentred for the next trial.

The initial average peak intensity of the rattle sound was set at 45 dB SPL, while the ambient noise level peaked at approximately 38 dB SPL. Instead of using a fixed number of trials, a maximum of 11 trials were given at the 45 dB level and the reliability of responding was assessed by a progressive check on the binomial probability of correct turns. Scores of 5/5, 7/8, or 9/11 trials correct were accepted as reliable performance, since the likelihood that they reflected chance responding was very low ($p < .05$). If a subject performed reliably at 45 dB then the intensity of the sound was reduced to 40 dB. Unreliable responding (three or more errors prior to trial 11) resulted in the intensity being stepped up to 55 dB.

Figure 1 illustrates that all the 7-month-old infants turned reliably at the 45 or 50 dB levels. By contrast, less than half the 5-month-olds turned reliably at these levels. Indeed, four of the six younger infants who were unreliable at 45 dB continued to respond at chance level with a 55 dB signal.

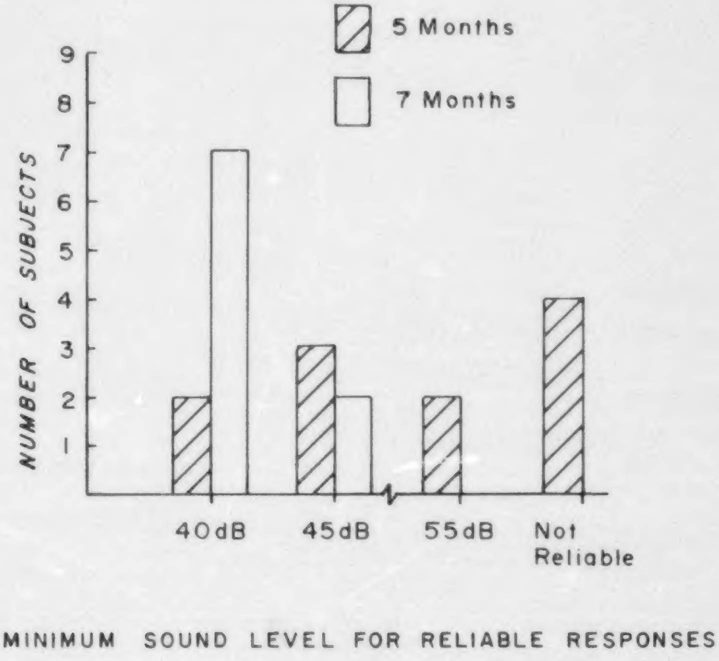

Figure 1: Number of 5- and 7-month-old infants turning reliably toward low intensity sounds

In this second experiment, the 5-month-old infants did not show uniformly consistent headturning responses to soft sounds, in contrast to the performance of their age mates in Experiment 1 with louder sounds. In fact, there was a significant difference ($\chi^2 = 5.60$, $p < .02$) between the 5-month-old groups in the individual reliability of their auditory localisation responses to 45 dB and 70 dB rattle sounds.

For the present, it must be concluded that my procedure of simply eliciting headturn responses, without attempting to bring such behaviour under the control of a reinforcing stimulus, does not permit sensitive hearing threshold assessments in infants as young as 5 months of age. However, there remains an important problem of clarifying to what extent poor consistency of response to low level sounds in 5-month-old infants is due to their poor discrimination ability, or to the low salience of soft sounds for such infants. In other words, their poor performance may have been due to the fact that they found the discrimination between the 45 dB signal and its 38 dB background noise much more difficult than the 7-month-old infants, or it may be that loud sounds are more likely to elicit reliable turning, or there may be an interaction between these factors. Certainly recent work reported by Schneider, Trehub and Bull (1979) indicates that 6-month-old infants may suffer impairments to their hearing thresholds from background masking noise more easily than older infants. These "masking" and "intensity" explanations can be tested in further research, but there is also a need to clarify the changes in learning ability and intentionally that underlie the dramatic improvements in the precision of listening and looking behaviour between about 4 and 7 months of age.

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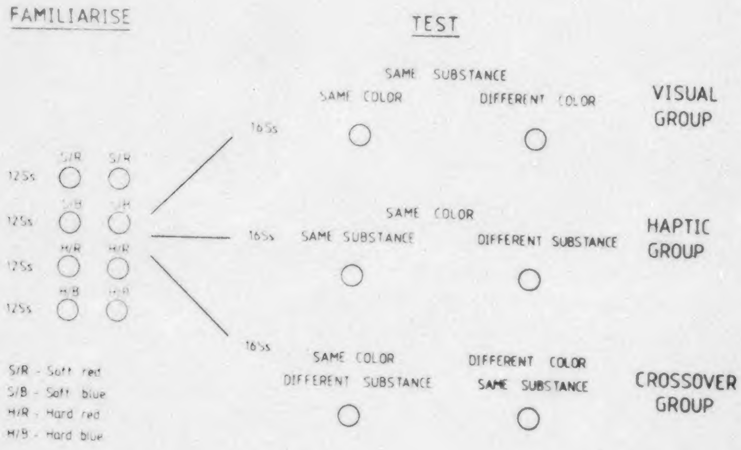
BIMODAL PERCEPTION IN SIX-MONTH-OLD INFANTS

Sharne A. Rolfe-Zikman
Monash University

The paired comparison or short-term familiarisation procedure is commonly used to assess recognition and discrimination in infants. This paradigm involves presentation of a stimulus to the infant for a period of familiarisation, this being followed by a test phase in which the familiarised stimulus is paired with a novel stimulus. The time that the infant attends to the novel pattern or object during the test, represented as a percentage of attention to both the novel and familiar test stimuli is taken as a measure of recognition or discrimination. Using this procedure, it has been shown that by their first birthday, infants differentially respond to novel and familiar stimuli under various conditions of familiarisation and testing. They look more at a novel stimulus following a period of visual familiarisation (Fagan, 1970, 1974; Fantz, 1964) and they haptically discriminate novel and familiar objects following a period of haptic familiarisation (Rose, Gottfried & Bridger, Note 1; Soroka, Corter & Abramovitch, 1979). The term "haptic" will be used frequently in this paper and is defined as a means of touching and exploring an object in which the skin, joints, and muscles function together in obtaining information--in other words, active touch. As well as being able to recognise stimuli intramodally, young infants can also visually discriminate novel and familiar objects following haptic familiarisation (Gottfried et al., 1977; Meltzoff & Borton, 1979; Ruff & Kohler, 1978). This ability is termed cross-modal or intermodal matching. Despite their diversity, all these experiments share a common element--they all employed unimodal familiarisation and test phases. In each phase, only one sense, either visual or haptic was being stimulated by the patterns or objects presented. Quite recently, multimodal perception, i.e., the interrelationship between sensory systems when stimulation impinges on more than one modality has also been investigated. Gottfried and others (Gottfried, Rose & Bridger, 1978; Rose, Gottfried & Bridger, 1979) reported the results of experiments in which infants received either unimodal, i.e., visual, or bimodal, i.e., simultaneous visual and haptic, experience with an object during a brief 20 second period of familiarisation. Twelve-month-old infants showed visual recognition, as indexed by greater attention to a novel shape, following each type of familiarisation. Recognition in 6-month-old infants, however, was impaired following bimodal experience. Gottfried and his coworkers proposed that the addition of haptic exploration to visual exploration interfered with acquisition or encoding of visual information about shape, possibly as a result of attention diffusion consequent upon the dual activities of looking and touching. Rolfe-Zikman and Day (Note 2) have recently completed two experiments which confirmed the results of the Gottfried group, but which modified the conclusions based on these outcomes. These experiments indicated that bimodal familiarisation impaired recognition in the experiments of Gottfried et al. and Rose et al. because these researchers used a unimodal test phase, i.e., the test objects were presented out of reach so that only visual inspection could occur, whereas the familiarisation objects were presented within reach for visual and haptic exploration. The experiments of Rolfe-Zikman and Day showed that 6-month-old infants can process bimodal information even when the familiarisation time is as short as 20 sec, and will show visual recognition of shape provided they can look at and touch the test objects. What is crucial for 6-month-olds is that familiarisation and test objects are both presented in the same way. The implications of this sensitivity in performance to changes in the way familiarisation and test objects are presented will not be discussed in any detail in this paper, but it would seem that these data bear on the question of identity constancy in infancy, i.e., the extent to which an object retains its identity as a particular object regardless of changes in, inter alia, its position, or even in this case what could be called the "touchability" of the object.

While this research has shown that 6-month-old infants can recognise a familiar shape following brief bimodal familiarisation provided the appropriate testing conditions are used, the contribution of the visual and haptic senses and any interaction between them has not been specified. This is so because shape can be perceived by vision alone, or touch alone or by both senses in interaction. The point to be made here is that a learning situation involving bimodal experience with an object may be essentially different to a unimodal learning situation because two senses and not one are being stimulated by the object. When the familiarisation period is brief, it is possible that the infant may attend to, or encode only the visual or only the haptic qualities of the object, and, if stimulation to both senses is being encoded, interactions between them are possible. When infants can recognise a familiar shape and thus discriminate between this and a novel shape as has been shown, it is clear that they have encoded shape information, but it is not clear whether this has been achieved by the visual sense alone, the haptic sense alone or both in interaction. A further experiment was therefore conducted to investigate systematically what information about an object an infant encodes during brief bimodal experience, by using stimulus object characteristics of particular relevance to one sense only. The characteristic selected as having particular relevance to vision was colour; substance, i.e., whether the object was hard or soft was selected as the characteristic of particular relevance to the haptic sense. The design of the experiment is shown in Figure 1.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SAME SUBSTANCE
DIFFERENT SUBSTANCE
HAPTIC GROUP
16.5s
SAME COLOR
DIFFERENT SUBSTANCE
DIFFERENT COLOR
SAME SUBSTANCE
CROSSOVER GROUP
S/R - Soft red
S/B - Soft blue
H/R - Hard red
H/B - Hard blue

Figure 1. The design of Experiment 1

Forty-eight 6-month-old infants participated in the experiment. All infants were bimodally familiarised with two identical spheres of 4cm in diameter. The spheres were soft red, soft blue, hard red and hard blue. The soft spheres were constructed by moulding a sponge rubber substance around a small wooden sphere 1.5cm in diamter. When palpated, objects so constructed feel soft and spongy. To maintain the surface texture and hence the initial visual appearance of the soft and hard objects as constant as possible, the hard spheres were constructed in a similar manner, however the sponge rubber substance was moulded around wooden spheres 3.5cm in diameter. The sponge rubber thus formed a thin shell around the hard interior, and when palpated these objects feel hard.

The familiarisation objects were presented for visual and haptic exploration until the infant had looked at them for 30 sec. This familiarisation time was selected on the basis of previous research (Fagan, 1977) which has indicated that infants of about 6 months discriminate novel and familiar colours in a visual intramodal task following this familiarisation period.

After the familiarisation phase, there were two 10 sec. bimodal test trials, in which the familiar object was paired with a novel object. For the first group, designated VISUAL, the novel object differed from the familiar object only in its visual qualities, i.e., it was the same substance as the familiar object, but a novel colour. For example, if the infant had been familiarised with soft red objects, the novel object would be soft blue. Discrimination in this group would only be possible if the infant had attended to and encoded the visual characteristic of the familiar object since the novel object differed from the familiar object only in its colour. For the second group, designated HAPTIC, the novel object differed from the familiar object in its haptic qualities, i.e., it was the same colour as the familiar object but a different substance. For example, if the familiar objects were soft blue the novel object would be hard blue. Discrimination in this group would be possible if the haptic qualities of the familiar object had been encoded. Of course, it must be noted that whereas colour can only be perceived visually, there are visual correlates of haptic differences in substance, i.e., once palpated, soft objects both look and feel different to hard objects.

A third group of subjects, designated CROSSOVER, were tested to determine the relative "salience" of the visual and haptic qualities by presenting in the test phase one object which was visually familiar and haptically novel, and one object which was haptically familiar and visually novel. For example, if the infant had been familiarised with a soft blue object, the test objects would be hard blue and soft red.

To summarise, these three groups enabled three main questions to be investigated. Firstly, does an infant attend to the visual qualities of an object during a brief bimodal familiarisation period? Secondly, does an infant attend to the haptic qualities of an object during bimodal familiarisation and thirdly, if both visually novel and haptically novel objects are presented, which object does the infant attend to most? During an experimental session, the infant was supported in a commercially produced car seat and secured by shoulder and lap sashes which did not restrict arm movements. The stimulus objects were fixed to rods which were fastened by pins onto a stimulus plate so that they projected horizontally towards the subject. The stimulus plate could be moved toward or away from the infant by activation of a motor. Between trials, the opening through which the objects were presented was covered by a grey sliding door.

The behaviour of the infant was recorded by two cameras, one placed above and directed down towards the stimulus objects, and one located behind them. The two signals were mixed to give a split screen recording of the infant's visual fixation and manipulation. Total duration of fixation and manipulation of each object during the test trials were scored from videotape records by an observer who did not know which object was novel and which familiar. The inter-observer reliability of this procedure was .91 for fixation duration and .97 for duration of manipulation. Preliminary analyses of the data indicated that fixation and manipulation times were not significantly related to either the colour of the object or whether they were hard or soft, so the data were combined for statistical analysis.

The results of the experiment are shown in Figure 2 and fixation and manipulation novelty percentages were calculated from these data. Recognition is evident in a group only if there is a statistically significant difference between these novelty percentages and an hypothesised mean of 50%, i.e., the expected percentage of fixation of the novel object if neither is preferred. Using this procedure, the only group to look at the novel object more than expected by chance was the VISUAL group. These infants spent more than 55% of the total test object viewing time looking at the novel coloured object, $\underline{t}(15) = 1.84$, $p < .05$. There was no indication of differential visual attention to the novel test object in the HAPTIC group. Subjects in the CROSSOVER group tended to look more at the haptically novel, visually familiar object, but this difference was not significant. Furthermore no group manipulated the novel object more than expected by chance.

These outcomes indicate that infants of 6 months do attend to the visual qualities of an object during a brief period of bimodal exploration, and that heightened visual interest in a new colour is not accompanied by increased haptic exploration.

The failure to find recognition in either mode in the HAPTIC group can be interpreted in a number of ways. Firstly, it is possible that the infants were not attending to the haptic qualities of the object during the brief familiarisation period, i.e., if the infants were attending to the colour of the objects only, then non-differential visual and haptic exploration of the test objects would be expected since both haptically novel and haptically familiar objects were the familiar colour. An alternate possibility is of course that evidence for differential responding would be found either if a longer familiarisation period were given, or if the data were scored in a different way. The point has been made in some previous experiments (Ruff, Note 3) that total manipulation duration may not be a particularly sensitive measure. A more sensitive measure may be how the test objects are manipulated--e.g., if the infants have been familiarised with soft objects they may attempt to palpate the test objects more than when the familiarisation objects are hard. In this latter case, infants may explore the surface of the test objects more. The haptic data of the experiment is currently being analysed in this way.

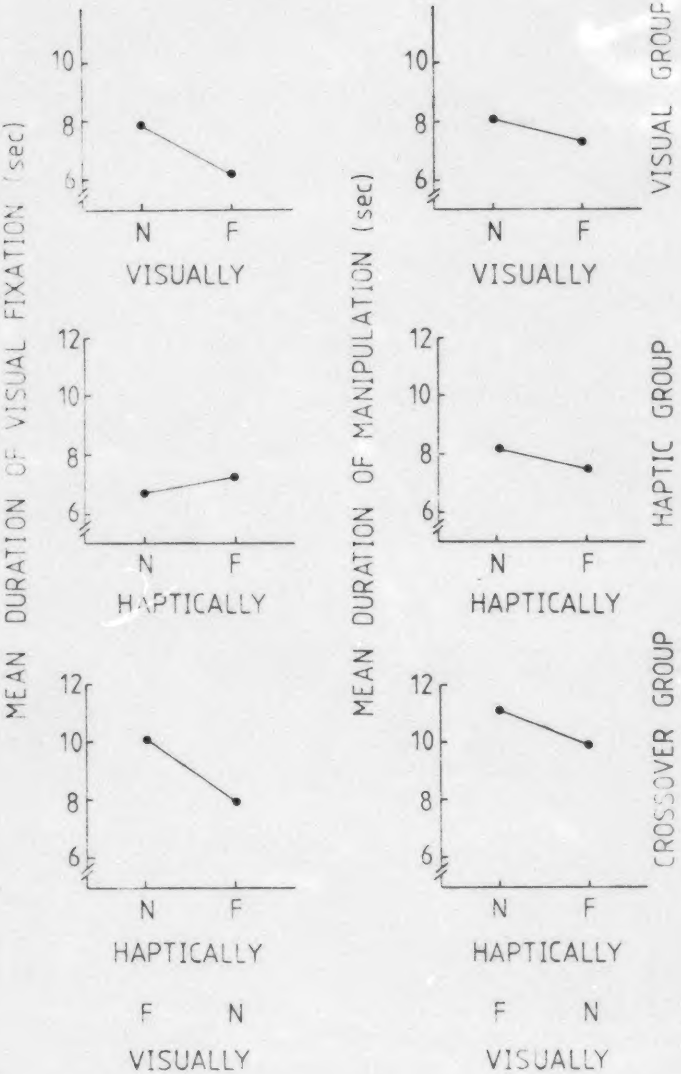

Figure 2. Mean duration of fixation and manipulation of novel and familiar objects in each group

That infants may indeed be attending to the haptic characteristics of the objects is indicated in the results of the final CROSSOVER group. In this group, one of the test objects was novel visually, while the other was novel haptically. If infants were not attending to the haptic qualities of the object this group's results should be the same as that of the VISUAL group. The difference in the results of these groups suggests that visual recognition was influenced by the presence of a haptically novel object in the test phase.

In summary, the experiments reported here have indicated that when novel and familiar stimulus objects differ in both their visual and haptic qualities, as in the case of shape, or in only their visual qualities, as in the case of colour, 6-month-old infants look more at the novel object. This indicates that they attend to the visual qualities of an object while looking at and haptically exploring it, and can selectively respond on the basis of visual cues alone. No evidence for recognition when objects differ only in their haptic qualities or when one object is haptically novel and the other visually novel has been found. The implications of these outcomes will be the subject of further enquiry currently under discussion.

Notes

1. Rose, S.A., Gottfried, A.W., & Bridger, W.H. Information processing by the sense of touch in infancy. Unpublished manuscript.

2. Rolfe-Zikman, S.A., & Day, R.H. Effects of the similarity and dissimilarity between familiarisation and test objects on recognition memory in infants following uni- and bi-modal familiarisation. Paper submitted for publication.

3. Ruff, H.A. Infants' manipulative exploration of objects. Paper submitted for publication.

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ACQUISITION OF MANIPULATIVE SKILL IN RELATION TO THE SHAPE AND SIZE OF THE OBJECT TO BE PREHENDED IN THE SIX TO TWELVE MONTH OLD INFANT: A LONGITUDINAL STUDY

Marcelle Schwartz
Lincoln Institute

Nearly 50 years ago Gesell and Halverson (1936) argued that motor development was essentially a maturation process, e.g., babies 6-months-old used a palmar grasp to pick up a cube and at 12 months they use a superior forefinger grip. This was attributed to genetically determined maturation of physiological processes. Environmental factors had little to do with it.

However, if you look at this data carefully you notice that infants only 20-weeks-old occasionally make full thumb opposition responses. How can this be if development is due to maturation? Some have called it "beginner's luck".

I would like to argue that precocious skilled responses are more adequately explained in terms of Bruner's (1974) model of skill acquisition. Like Bernstein (1967), Bruner argues that all actions are voluntary and are the solution to a motor problem. The growth of skill is neither the result of maturation nor the result of the shaping effects of reinforcement, but is the result of developing appropriate plans and strategies for action. When a given strategy is sufficiently practised so that little attention is required for its smooth execution, information processing capacity can be utilised by a re-analysis of the problem. This may result in an efficient response being replaced by an initially more clumsy one. Thus development does not proceed smoothly but occurs in quantum jumps. I wish to hypothesise that response variability will be high during that phase of skill acquisition when the infant has established general strategies or rules for grasping objects but still has difficulty in identifying the salient dimensions of the object which impose special requirements on the task. That is, Bruner's quantum changes in strategy that govern voluntary responses occur on a trial to trial basis as the infant adapts his strategy to the perceived characteristics of the object. Only when the perception of salient features of the object being prehended is stabilised, will the mode of response appear stable. This hypothesis would be strengthened if it could also be shown, that there is a strong tendency for an object based response selectivity. Precocious skilled responses must be seen in the context of response variability.

Method

Two groups of eight infants, one group aged 26 weeks, the other 37 weeks at the commencement of the study, were observed for 12 weeks in the task of prehending a 2.5cm sided cube, a 0.6cm sided cube pellet and a rod, 2.5cm in diameter and 9cm long. There were four of each kind of object, each differing in colour. The different colours maintained interest in the activity and provided an irrelevant dimension in the task.

The infants were tested at fortnightly intervals. Each kind of object was presented six times consecutively and then immediately followed by the next object and so on, making 18 consecutive trials in all. Presentation order was controlled in the usual way and fixed for each infant. The colour of the objects however, varied continuously in no predetermined order. The level of skill used by the subject when picking up the object was scored according to Halverson's (1931) classification of grasp responses.

Whether or not these grasp patterns reflect age related development that is firmly established, is irrelevant. They do show successive levels of skill attainment in terms of the development of full thumb opposition. On this basis the ordered set of 10 levels of skill described by Halverson were assigned scores of 1 to 10.

Results

Response variability was calculated from the raw data by, firstly, establishing the "difference score" from one trial to the next in every sequence of 18 trials, and secondly, by determining the "mean difference score" associated with each of the three objects and the two changeover trials when one subject was replaced by another. Thus response variability was compared for four stimulus conditions (the three subjects and the changeover) over a 12 week period with fortnightly testing.

An analysis of variance indicated that a significant difference in the mean response variability was attributable to the stimulus condition ($F(13,42) = 12.15$, $p < .001$). There were no significant age effects, no session effects and no interactions. Analysis indicated that there was significantly less response variability when the rod was being prehended, compared to either the cube or the pellet. The greatest change in response variability occurred when one object was replaced by another.

Response selectivity was examined in terms of the distribution of specific responses to the three objects. The question arises as to whether the distribution of all response types should be examined, or, if only some, which? The decision to study the development of response skills at or above level 7 was made because such responses accounted for more than 70% of all responses made by the older group of infants. The analysis was further amplified by considering responses at levels 7 and 8 together, these being two levels of partial thumb opposition, and by considering responses at levels 9 and 10 together because these represent two levels of full thumb opposition. The distribution of partial and full opposition responses for each of the three objects is shown in Table 1.

The distribution of the two specified response patterns was examined using a three-way analysis of variance for three repeated measures (Keppel, 1973). The two age groups were treated separately. The younger group of infants showed significantly more responses of partial thumb opposition type than full thumb opposition responses ($F(1,7) = 36.86$, $p < .001$), and together both responses became more frequent throughout the duration of the experiment ($F(5,35) = 18.3972$, $p < .001$). There was a significant interaction between stimulus condition and response type ($F(2,14) = 63.33$, $p < .001$), indicating that the infants tended to make selected responses to the three objects. The Newman-Keuls procedure indicates that it is the rod which elicits

Table 1

Distribution of Full and Partial Thumb Opposition Responses to Three Objects

		Sessions					
Younger infants		1	2	3	4	5	6
Partial thumb opposition responses	Rod	16	19	28	23	34	41
	Cube	14	23	30	32	19	25
	Pellet	9	12	14	19	19	26
Full thumb opposition responses	Rod	2	3	0	4	7	4
	Cube	1	3	1	5	15	15
	Pellet	3	5	4	10	12	17
Older infants							
Partial thumb opposition responses	Rod	32	33	38	31	42	40
	Cube	32	30	30	33	28	29
	Pellet	14	18	14	8	5	7
Full thumb opposition responses	Rod	3	8	3	10	3	2
	Cube	4	10	8	8	10	9
	Pellet	20	22	22	31	35	38

the selective behaviour, with significantly fewer full opposition responses compared to the other two objects. Like the younger group, the older group showed significantly more responses of the partial thumb opposition type than full thumb opposition responses ($F(1,7) = 13.72$, $p < .01$), but unlike the younger group, there is no session effect. Again, the interation between stimulus condition and response type is significant ($F(2,14) = 44.49$, $p < .001$). In addition, the three-way interaction is significant ($F(10,70) = 3.38$, $p < .001$). The Newman-Keuls procedure indicates that the infants respond differently to the three objects. The pellet elicits significantly more full thumb opposition responses and significantly fewer partial thumb opposition responses than either the rod or the cube. Overall, the infants make significantly more full thumb opposition responses, compared to partial thumb opposition respones, to the pellet. The triple interaction indicates that this pattern of responses develops over the 12 week period of the experiment. The situation is reversed with the rod and cube. These objects elicit more partial thumb opposition responses than full thumb opposition responses. Even between these objects, there is evidence that the distribution of these two classes of response, is different. The rod elicits significantly more partial thumb opposition responses than the cube, while the cube elicits more full thumb opposition responses, although the last comparison just falls short of significance.

Discussion

The occurrence of precocious responding is intriguing. In this study, 4% of all responses made by 26-week-olds were of the full thumb opposition type. This was not due to the efforts of a single child, but of half the group. The occurrence of high level responses by relatively young infants, while infrequent, is apparently widespread. Moreover, it occurred to each of the three objects offered to the children. Inevitably, the occurrence of high level responses among a number of less skillful responses in younger infants, raises questions concerning the significance of response variability. Response variability simply cannot be regarded as the persistence of low level responding by relatively "mature" infants.

The data indicated that response variability was not a uniform characteristic of infant prehension. Infants were much more likely to use a consistent method for picking up the rod and variable responses when prehending the cube and pellet. This difference in behaviour to the different objects, was evident from both the younger and older infants and did not change over the 12 weeks of observation. In addition both groups showed the largest response variability when one object was replaced by another different object. The data suggests that the properties of the objects being prehended have a significant effect on response variability, and hence on processes mediating the action of prehension.

Gesell and Halverson (1936) noted that the infant does not adapt any single method of prehension to the exclusion of other methods. There was considerable overlap of the age scores in which the various grasp responses occurred. Nevertheless, they concluded, "there is a central developmental trend" (p. 360). Therefore it might be inferred, that response variability is due to the persistence of low level responses among more age appropriate higher level responses, The data concerning the distribution of specific responses to the three objects, does not support this interpretation. The youngest group increasingly responds to the rod with a partial thumb opposition grip, and even more interestingly, the use of the full thumb opposition response remains consistently negligible over the 12 week period. The older group maintains this pattern of responding, so that there is no evidence for a gradual increase in skill over the total age span. They apparently have selected a low level response and stick to it. Thus the rod features, not only because it is responded to in a more consistent manner than the other objects, but because it calls for less skill in its handling. A consistent method of grasping does not necessarily mean the attainment of a high level of skill, but is rather the attainment of an appropriate level of skill for the task.

The relatively high level of response variability to the cube and pellet has already been noted. These two objects are also associated with the development of more skilled responses. The question arises, as to whether the high level of response variability reflects the gradual ability to organise a full thumb opposition response, or the difficulty in selecting the most appropriate response for the particular object. It is likely that full thumb opposition demands a level of control not easily achieved by the younger infant. However, the data are quite clear, even the youngest infants in this study were able to make full thumb opposition responses. Explanations in terms of maturation cannot be satisfactory. On the other hand, the gradual increase in the use of full thumb opposition, may indicate that this response is progressively more readily organised. Nonetheless, the data suggests that superimposed on the problems of response organisation, is that of appropriate response selection.

This aspect of skill depends on the infants' ability to perceive and select those features of the object which are relevant to the task. This is most clearly seen in the analysis of the infants' responses to the cube, which neither shows a consistent steady increase in skill, nor the simple maintenance of a less skilled response. The younger group responds to the cube in much the same way as they do the pellet. There is an increasing incidence of full thumb opposition responses over the 12 week period, and at the end of this period, the distribution of the two types of responses to the cube and pellet are indistinguishable. The older group however, have different response patterns for the two objects. They continue the trend toward full opposition responses for the pellet, but fall back on partial thumb opposition responses for the cube. It is not possible therefore, to argue that high response variability simply reflects the increasing incidence of a full opposition response as it becomes increasingly easier to organise. It may also occur when the final outcome is predominantly a less skilled response. The changing pattern of response to the cube suggests that the infants are engaged in an active process of selecting the most salient object feature, on which to base their plan of action, and that for this object, there is a major shift in strategy around 9 or 10 months of age. However, this is not a complete shift. The older infant continues to make significantly fewer partial thumb opposition responses to the cube, compared to the rod, while persisting with a comparatively high level of full thumb opposition responses, when compared to the rod, but not when compared to the pellet. The ambivalence in response to the cube, suggests that the relatively high level of response variability may be attributed to the difficulty the infant has in identifying the salient dimension for the task of prehending this particular object. It may be inferred, that all response variability may be due in part to the continual process of adapting strategy to the perceived characteristics of the object.

Why the cube should present the most difficulty in task analysis, as evidenced by the persistence of mixed response types, is less clear. It is possible that when the cube is presented to the infant in the context of similar presentations of the rod and pellet, it is perceived of as having intermediate characteristics. Whether it is size or shape that is the basis of the infant's response, the cube's properties are intermediate. My hunch is that it is size.

In conclusion, the findings provide initial support for the hypothesis that response variability is the result of organisational processes that control a voluntary response such as grasping, and that an important aspect of this process is the perception and selection of appropriate object features upon which to construct a response strategy. Precocious responses may be regarded as a relatively occasional instance of appropriate feature selection coinciding with appropriate ordering of the constituents of the response, by the younger infant. The findings also indicate that infants develop appropriate strategies to objects rather than simply more skillful responses to objects.

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THE RELATIONSHIP BETWEEN TOUCH AND VISION WITH YOUNG CHILDREN

Roderick P. Power
Macquarie University

Harry McGurk
University of Surrey, England

Under conditions where different sensory information about a single object is simultaneously presented to vision and touch, adults show visual dominance (Kornheiser, 1976; Welch, 1978). Visual dominance occurs when the observer sees (e.g., Rock & Victor, 1964), or is led to believe (e.g., Miller, 1972), that an object being handled is the same as that being seen, but a lens has changed the visual image. Such dominance or capture occurs despite either special training which might be expected to minimise the phenomenon (Power & Graham, 1976), or extreme distortion of the visual image (Power, 1980). In general, vision entirely dominates touch, although some situations lead to a reduction of the effect (Over, 1966; Welch, Widawski, Harrington & Warren, 1979; Power, 1980).

There have been many developmental studies on transfer between various sense modalities (e.g., Milner & Bryant, 1968; Goodnow, 1971; Cronin, 1973), but the response to intermodal conflict has received little attention. There is, however, evidence that visual dominance does occur in some situations during infancy. For instance, Walk and Gibson (1961) found that human infants and other young animals would not venture onto the "deep" side of a visual cliff, although haptically it was obvious that there was a solid surface. On the other hand, Page and Locke (1977) found no differences attributable to age in the performance of children between 5 and 13 years on a series of touch-vision conflict tasks. Also, they found no visual dominance in their subjects. There are, however, important differences between the procedures used by Rock and Victor (1964) which led to visual dominance in adults, and the procedures used by Page and Locke with children, although they regarded their experiment as an extension of Rock and Victor's work. In the Rock and Victor study the observer could see his or her hand exploring the object, although the hand was covered by a thin cloth. In Page and Locke's study, however, "At no time could the subject see his own hand, or an outline of it, beneath the backing cloth in which the block was suspended" (p. 52). Unless the observer can see his handling of the object or is otherwise convinced that only one object is present dominance may not occur (Miller, 1972). In the absence of adult responses to Page and Locke's procedures, it is difficult to assess the degree to which their findings are attributable to age or to procedural and apparatus differences. It is also a matter for concern that Page and Locke appear to have taken no precautions to ensure that their subjects actually understood their task.

It is of importance, therefore, to establish how young children respond to conflicting visual and tactual information, as a prelude to studying any developmental changes which may occur in such behaviour.

In conditions like those of Rock and Victor, adults have no awareness of intermodal conflict. Rather, tactual input is experienced as consistent with visual input: unity of the senses is preserved by the phenomenon of visual capture. The experiment reported below was designed to assess the extent to which young children manifest visual capture, tactual capture, visual-tactual compromise or visual-tactual conflict.

Various procedures have been adopted with adults, some of which have involved an element of cross-modal matching. Pilot work showed that we should avoid any such cross-modal judgments. We found, as have earlier investigators, that intermodal matching under normal conditions was less efficient than intramodal matching, whether visual-visual or tactual-tactual (cf. Abravanel, 1971; Connolly & Jones, 1970; Rose, Blank & Bridger, 1972). Accordingly, we developed training and testing procedures whereby both target and selection stimuli were always presented in the same fashion; either both visually, both tactually or both visuo-tactually. These procedures avoided the necessity for cross-modal transfer whilst still allowing visual dominance, touch dominance, touch-vision integration or conflict to be expressed.

Method

Subjects. All the available 4- to 5-year-old children from two local nursery schools were recruited to the study. Testing was begun with 23 children. Data from one child, however, were excluded from analysis because of distress and from three children because of failure to reach the training criterion. The ages of the remaining 19 children ranged from 4 years 0 months to 5 years 1 month with a mean of 4 years 8 months.

Apparatus. The apparatus containing the target stimulus consisted of a wooden box 310mm wide, 205mm deep and 500mm high. The target was a flat, white piece of perspex, 25mm square and 3mm thick, which was mounted on a 12mm wooden rod which passed through a loose black cloth. This cloth was attached to the upper portion of the child's side of the box, and prevented him or her from seeing the target except through the viewing aperture, a 12mm hole in the top of the box. A +4 diopter cylindrical lens which optically expanded one axis, while maintaining the other constant, was suspended 165mm below the aperture. The distance from the lens to the target was 125mm, and these dimensions gave a rectangular visual image 25mm by 37mm. Wooden partitions prevented the child from seeing the edge of the lens. The child could reach into the front of the box with the palm up, fingers extended, to feel the square. Thus the child could examine the square visually, haptically or by both modalities simultaneously. The material was sufficiently opaque to prevent the child from observing details of his or her hand, but thin enough for the square to be clearly felt. The child could, of course, observe finger movements around the object. This made it clear that he or she was feeling and seeing the same object. The back of the box was open so that the target was well illuminated.

The response display comprised three perspex rectangles 3mm thick. One, 25mm by 25mm, was visually and haptically identical to the target. A second was 25mm by 37mm, corresponding to the visual image of the target square when it was viewed through the lens. The third was 25mm by 30mm, and thus was intermediate between the visual and haptic image of the target square. The rectangles were glued to the ends of 12mm rods, and were mounted on a 300mm by 100mm by 15mm wooden board so that the surface of each shape was located parallel to and 45mm above the top surface of the board in order to facilitate haptic exploration. The centres of the rectangles were 110mm apart and the 25mm sides were parallel with the longer sides of the block.

Three such displays were constructed so that all six possible left to right orderings of the three shapes could be used.

Three training sets were similar in general construction to those just described, except that the shapes were 25mm by 19mm, 25mm by 34mm, and 25mm by 53mm.

Procedure

Each child completed all three experimental conditions. Training and test phases followed successively for each condition. The three conditions were presented in different sequences such that each occurred approximately equally often at first, second and third positions. Test observations were monocular with eye preference left to the child. A record was kept of each child's performance in terms of the number of trials to criterion during training and of the matching object selected under each test condition.

Children were tested individually. Under both training and test conditions the child was told that the task was to find in the response array the shape which most closely resembled the target.

During training the child sat at a low table on which the materials were presented. Two training boards were placed on the table, one behind the other, relative to the child. Under all three conditions, training was continued until the three successive correct matches had been made within the predetermined maximum of nine trials.

For visual training, two shapes on the nearer board were concealed by black cloth. The child was asked to look at the remaining shape and, from the further board, to select the shape which matched it. Target shape and position in the array were systematically varied from trial to trial. Visual-haptic training was similar, except that the child was asked to look at and feel the target shape and to look at and feel each of the comparison shapes before selecting a match. Several subjects had to be actively encouraged to follow these instructions but care was taken to ensure that each child handled all three alternatives before making a match.

For haptic training, shapes on the training boards were covered with black cloth. The child was asked, and as necessary assisted, to put a hand under the cloth to explore the target shape and, on the basis of haptic exploration, to select the alternative most like it from the rear set. To facilitate simultaneous contrast, subjects were encouraged to explore the target with one hand and the alternatives with the other.

During visual testing, the child was asked to look through the eye piece at the target shape in the display box and then to look at the set of alternatives and to visually select the shape most similar to the target. For visual-haptic testing, the child was required to look at the target in the box and simultaneously explore the shape haptically through the black cloth. Then the child was required to look at and to feel each of the comparison shapes and report which one was most like the target. Under haptic testing, in which no vision was allowed, the child was asked to insert his hand into the box, to find and feel around the target shape and, by haptic exploration, to find the comparison shape most similar to the one in the box. As with training, the child was encouraged to explore target and alternatives simultaneously.

Results

Training sessions. The training sessions showed a very clear distinction between the conditions involving vision and the condition involving only haptic stimulation. Of the 19 children, 15 reached the criterion at the end of the first three trials in the vision alone condition, and 14 reached it on the first three trials in the visual-haptic condition, whereas only 6 in the haptic alone condition reached it in the minimum number of trials (Cochran's Q = 12.7; $p < 0.01$).

Testing sessions. For purposes of analysis a score of 1 was assigned to a touch match, a score of 2 to an intermediate match, and 3 to a visual match. The median score in the vision condition was 3, the median for the conflict conditions was 3, and for the touch criterion was 1. A Friedman two-way analysis of variance gives $\chi^2 = 20.7$ (df = 2; $p < 0.001$) illustrating a significant tendency for stimuli under visual only and visual-haptic conditions to be perceived as similar to each other and different from the target stimulus presented under the haptic condition only. In other words, intermodal conflict was avoided by a process of visual capture. With respect to individual performance, 8 of the 19 children had patterns of scores indicating accurate perceptions under visual and haptic conditions and visual dominance under the visual-haptic presentations (i.e., scores of 3, 1, and 3 respectively). A further 8 subjects showed visual dominance since their scores (3, 2, and 3, or 2, 1, and 2) showed the visual and visual-haptic scores to be the same, and the haptic alone score to be closer to the actual object. There were no instances of tactual dominance nor was there a single subject who reported any experience of intermodal conflict or any awareness that different information was being presented to vision and touch. Nor was there the variability in the data which might indicate any form of conflict.

Discussion

This experiment involving pre-school children has yielded evidence for visual capture under visual-haptic conflict conditions comparable to that reported by other investigators working with adults (Power & Graham, 1976; Rock & Victor, 1964), and older children (Power, 1980). Two factors may account for differences between the present results and those reported by Page and Locke (1977), who could find little evidence of visual dominance among 5- to 13-year-old subjects. In the first place, the training procedure adopted here served to familiarise subjects with the experimental task and to provide an index of their ability to match objects visually or haptically under normal conditions of presentation. Incidentally, data from this part of the study confirm that visual-visual matching is achieved more readily by pre-school children than haptic-haptic matching (Rose, Blank & Bridger, 1972; Rudel & Teuber, 1964). In the second place, the present subjects, unlike those of Page and Locke, were able to observe their manual exploration of the target stimulus under the conflict condition, thus establishing that a single object was the locus of visual and tactual inputs.

Like adults, then, pre-school children when presented with different visual and tactual information about the same object achieve a unified percept via visual dominance. By this age at least, the expectancy for objects to feel as they look, for vision and touch to yield congruent information, is so entrenched as to ensure perceptual unity even under conditions of considerable potential conflict. Whether such perceptual unity is a biological given or whether it is an expectancy which develops on the basis of learning and experience is as yet an unresolved issue. It becomes increasingly likely, however, that the unity is biologically determined, given the recent work of people like Meltzoff and Borton (1979), which shows that a neonate can visually recognise an orally felt shape, and Muir and Field (1979), which shows that newborn babies can successfully orientate towards sounds on the right and left.

Acknowledgements

This research was carried out whilst Roderick Power was on study leave at the University of Surrey. We are grateful to Simon Best and Liz Painter for assistance during testing.

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WHAT'S SO SPATIAL ABOUT TIME?

Roger Wales
University of Melbourne

In many languages there is a coincidence of spatial and temporal terms. This paper will explore some of the grounds for supporting that this coincidence may be no coincidence at all. Rather that it may be a consequence of the way in which spatial notions are utilized as descriptive devices for the temporal domain. To notice something of the range of the coincidence consider the following expressions in English: *before*, *after*, *time was short*, *the day was long*, *the end is near*, *Sunday seems far away*, *at 12 o'clock*, *on Monday*, *in May*, *ahead of*, *in front of*, *early*, *trouble lies ahead*, *the worst is behind us*, *time flew by*, *the class arrived before we knew it*, etc. The fact that temporal expressions are often recruited from spatial ones has often been commented on by linguists and philosophers of the past. For our present purposes we shall concentrate our attention on three recent discussions. They contrast with each other in their characterization of the nature of the relationship.

Three Views of the Spatial/Temporal Relationship in Language

All three expositors discuss the relationship from the viewpoint of the "time-line". What this is, is a view that time is interpreted in terms of locations and/or movements on a line, and thus a spatial framework is expressed for the interpretation. The ways in which the three expositions differ has to do with the detailed interpretation of the time-line. Thus Herbert Clark (1973) expressed the view that the spatial interpretation of the time-line is essentially unidimensional, where even expressions such as *over the weekend* involve a single linear path. For Clark the interpretation of the time-line is then conducted from a canonical viewpoint whereby what is in front of the individual -- ego -- is taken as being future (as in *trouble lies ahead*) and the past is behind ego (as in *the worst is behind us*). The canonical ego is thus centred on the time-line in the present. Clark argues for two possible, independent versions of this canonical interpretation of the time-line. Either the individual is moving forward into the future (moving ego), or time is moving pastward from the future (moving time). He draws an analogy for these views, of travelling along a highway in a car -- we may conceive of ourselves moving forward with the road relatively fixed, or ourselves relatively fixed in position with the road flowing past us. The usefulness of Clark's paper is the degree of explicitness with which he argues the form of mapping from spatial to temporal domains is said to take. He adduces a number of further specific hypotheses from the point of view of the canonical reference, for example that markedness will predict the order of acquisition (i.e., the simpler and more general will be acquired first, in this case being predicted from the spatial interpretation first).

A somewhat different view of the time-line is taken by Elizabeth Traugott (1978). Her view is a consequence of reviewing the way a great many languages have actually utilized something similar to the time-line. She concludes that there are two very general (perhaps universal) interpretative modes: a single proximal-distal one (*now* vs *then*), and an Event 1 + other sequence The difference is captured by the difference between the following two sentences: *my exams lie* *ahead of me* vs *my exams lie ahead of my holidays*. This position might seem to negate Clark's (although note: *my exams lie ahead and I'll eventually have to face them*). Why Trungott takes a less strong view than Clark seems to be partly because there is some cross-linguistic evidence that occasional bidimensional spatial representations occur, e.g., Chinese can apparently use both vertical and even lateral (left-right) dimensions for temporal expressions. A further query of Clark's position comes from the apparent fact that some languages may interpret the future as behind (e.g., Quechua -- Sohlberg, personal communication; New Guinea Pidgin -- Ades, personal communication).

The third view of the time-line is taken from Miller and Johnson-Laird (1976); they in turn acknowledge their indebtedness to McTaggart (1927). A distinction is made between the discrete passage of time (*from moment to moment*) and the continuous one (*time is passing slowly*). These are assumed to be similar in terms of their associated spatial interpretations within the framework of the time-line as they expound it. The past is taken as equivalent to "earlier than now", the future is "later than now", and the present "neither earlier nor later than now". Thus time is seen as moving along the time-line into the future. This position is structurally ambiguous if compared to Clark's model. It is either similar to moving ego, or more plausibly given the form of their exposition, it is the inverse of the directionality of the moving time model. Thus for Clark time is moving out of the future into the past, whereas for Miller and Johnson-Laird it can be interpreted as moving out of the past into the future. One intriguing acquisition issue is also raised by Miller and Johnson-Laird, where they suggest that development of temporal notions, being ordered, may be linked to the development of number.

As we proceed we shall have to elaborate the models in more detail. Suffice it to say, for the present, that they make quite specific and at some points apparently contradictory claims. They cannot all be right, even if they all deserve prizes! Already a number of specific questions are clear. Thus which way are we/time moving? Is the canonical front/future, past/behind representation the correct one? Is the moving ego concept independent of moving time? Does markedness predict the order of acquisition? Is the acquisition of notions of time related to the acquisition of notions of number? And then of course there is the set of questions concerning how we collect and sort data relevant to such issues. Three studies will be related which illustrate some of the possible methods which can be used to tackle such questions, and the implications which follow their results.

Study I:

Spatial Interpretations for Temporal Expressions

If it is true that young children acquire temporal expressions from spatial precursors it should be the case, minimally, that they will give some spatial interpretations to temporal expressions even where adults are now disinclined to do so. This expectation was the focus of our first study. Spatial arrangements of dolls, such as those in Fig. 1(a) and (b), were systematically presented to 20 children mean age 3.5 years, and 20 mean age 5.5 years. With reference to the doll marked 0 in Fig. 1, they were asked to indicate which doll was

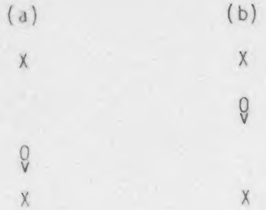


Figure 1. Array presented to children, where X and O are dolls; and v indicates direction of gaze of doll.

in front of, *behind*, *before*, or *after*, O. The order of questions was systematically varied across subjects. Not surprisingly, the older children performed better overall than the younger. If *before* is assumed to take the same spatial reading as *in front of*, and *after* the same as *behind*, then *before* and *after* were reliably harder in these contexts than *in front of* and *behind* -- again not so surprisingly. Also in *front* and *before* were easier than *after* and *behind* suggesting some form of markedness. Most directly supportive of the expected interdependence was the fact that in both age groups only children who got *in front of* correct got *before* correct, and only children who got *behind* correct got *after* correct. This suggests some degree of dependence of the temporal on the spatial. However, it would be perfectly reasonable for adults to behave somewhat similarly, since if one has the opportunity and inclination it is still possible to *stand before the Queen*, although it would now be more archaic to *follow after her*.

Therefore the spatial/temporal contrast was also looked at with arrays such as those depicted in Fig. 2 (with the variation in relative

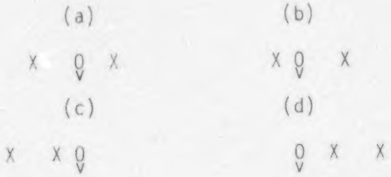


Figure 2. Arrays presented to children where X and O are dolls whose direction of gaze is indicated by v.

position being systematically varied, as also the order of questions). This time the same children as before were asked to assign interpretation with the following introduction, "This doll (O) is talking to one of these two dolls (Xs). Which doll is it if this doll (O) tells you it's the one -- *here*", (*there*, *now*, or *then*). Again the older children were significantly better than the younger, and *here* and *there* were easier than their temporal analogues *now* and *then*. As before no child identified *now* consistently as the nearer X to O unless they consistently also did so for *here*, and a similar dependence was found for *then* or *there*. This is a more striking result since the children responded as readily to *now* and *then* as to *here* and *there*, a pattern no adult would give without being pressed. It is also worth noting that in this instance *there* and *then* were easier than *now* and *here*, a result having implications for the markedness hypothesis which will be discussed later.

This study is really a demonstration one, in that what it establishes is that the children do exhibit some degree of spatial dependence in their interpretation of temporal expressions. Thus it serves to establish a phenomenon requiring elucidation and explanation rather than mere conjecture. The next two studies attempt to test more precisely what is going on in the nature of the dependence.

Study II:

Sequence and Similarity

This second study was conducted with John Munro (see Munro, 1980). If children are interpreting temporal expression in terms of the timeline then one place it might be expected to reveal itself is in those terms used specifically for ordered events such as *before*, *after*, *first*, *last*, etc. Building on her earlier studies of the children's spontaneous use of such expressions as *before*, *after*, or *when* (Clark, 1969), Eve Clark (1971) used these terms as subordinating conjunctions in an experimental study with children aged 3 and 5 years. From these studies she postulated three steps in development: (1) where children do not comprehend the terms. Rather they seem to use the assumption that the order of specification of events in the sentence is the intended order of events (the order of mention strategy); (2) where children understand *before* but not *after*, and for the latter either use an order of mention strategy, or treat it as being synonymous with *before*; and (3) where the children comprehend both terms. This developmental sequence is accounted for by appeal to the Semantic Features hypothesis: that is, that the adult meaning of the term may be described in terms of a number of components of meaning, or semantic features. Thus, semantic components or features for *before* and *after* might be (1) *Time*, (2) *Simultaneous*, interpreted as *at the time when*, and (3) *Prior*, interpreted as *earlier than*. Each of the components is hypothesized to be polarized with two values. *Time* has the values (± Spatial location), *Simultaneous* has the values (+ Simultaneous) meaning *at the same time as* and (- Simultaneous) meaning *not at the same time as*, and *Prior* has the values (+ Prior) meaning *earlier than* and (- Prior) meaning *later than*. The hypothesis proposed that children acquire the meaning of each word, component by component, in a hierarchical way. A predicted intermediate stage of comprehension associated with the acquisition of (- Simultaneous) is the *order of mention strategy*.

Subsequent studies have generally lent support for Clark's predictions. The order of mention strategy has frequently been observed, although alternative comprehension strategies have been proposed for older children; and although *before* is frequently found to be easier than *after*, little evidence for *after* being interpreted as *before* has been forthcoming. Although not directly a study of linguistic development, Piaget (1969) accounts for the mature acquisition of Simultaneity and Sequence in terms of dissociation, at that point, of spatial and temporal data as a consequence of the acquisition of operational reasoning. He also seems to imply that notions of Simultaneity are constructed from notions of Sequence.

The two approaches share common assumptions. Both assume that temporal language acquisition has an underlying nonlinguistic cognitive base, and that temporal linguistic reference is derived from spatial knowledge. They differ, however, in terms of the nature of this cognitive basis. Clark (1971) assumed that the child's perceptual construction of space and spatial linguistic reference provided the foundation for temporal reference. The Piagetian framework sees the child as constructing an action-based knowledge of its world.

The present study is based on an analysis of this assumed underlying cognitive structure, and derived from the assumptions that comprehension of temporal reference involves translation into a nonlinguistic cognitive form, and that this translation involves the recoding of temporal data in terms of a spatial model. The language user is assumed to construct a representation of a temporal configuration by coding temporal data in terms of a linear model. Simultaneous configurations are coded by reference to one point; the two instants are represented as concurrent. Sequential configurations are coded in terms of two points, with the temporal orientation of the sequence represented by their spatial orientation.

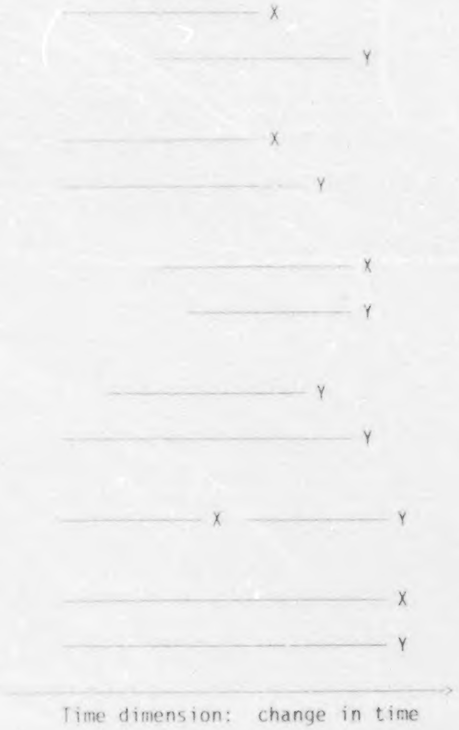
The two types of configuration are assumed to differ in the amount of data involved in constructing a linear representation of each. Comprehension of a sequential configuration requires a greater amount of spatial reference than comprehension of a simultaneous configuration, since the former requires reference to two points on the linear model, while the latter requires reference to one point. This assumption was used to predict that simultaneous configurations are comprehended earlier than sequential reference.

Changes in the child's use of the spatial recoding or linear organizing scheme are proposed to account for trends in comprehension of temporal configurations. Four levels of linear organization may be identified as follows: (1) temporal data are coded in terms of a single diffuse spatial region, permitting temporal reference to a single past or future event, with neither durational nor instantaneous features differentiated; (2) temporal data are coded in terms of two points but without the orientation of the points retained, permitting discrimination between simultaneous and nonsimultaneous configurations but not allowing the order of instants to be coded; (3) temporal data are coded in terms of two points, with the points arranged in a particular orientation, permitting representation of some temporal sequences correctly, but not others; and (4) temporal data are coded in terms of two points arranged in the intended sequence. The four levels, it is suggested, are acquired in the order specified. The level of linear organization available to the child provides an upper limit to the representation of the temporal configuration constructed by him. This order leads to the following predicted trend in temporal acquisition: (1) comprehension of reference to a single temporal event; (2) comprehension of reference to a simultaneity and nonsimultaneity; (3) comprehension of reference to particular sequences; and (4) a mature comprehension of reference to simultaneity and sequence. This is similar to E. Clark's semantic feature hypothesis but is more general.

A second prediction relates to the comparative difficulty of various types of temporal linguistic reference. The terms *before*, *after* and *at the same time as* are classified as instances of a relative reference system; each relates events temporally by specifying one in terms of the other. The terms *first*, *last*, and *together* are classified as instances of a *categorical* reference system, in which each event is specified in terms of a dimension external to the sequence. Categorical reference is recoded as specifies two points in a linear arrangement, each instant associated with a point. Relative reference specifies a point, and a set of possible points or a region of the time vector. On this basis, categorical reference is predicted to facilitate linear organization, and is therefore easier to comprehend than corresponding relative reference.

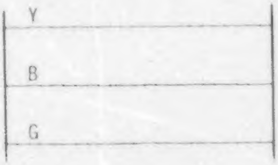
In past studies the task has always involved comparing the temporal order of two events such as A (before after) B. However, both A and B have independent beginnings and ends which may or may not overlap with each other. Thus there are in fact six possible temporal patterns which may be schematized as shown in Figure 3.

Figure 3



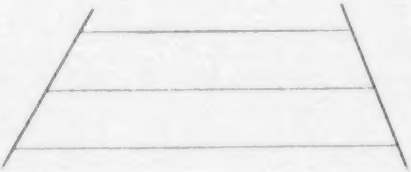
These types of patterns were presented in this study to two groups of children, 20 of mean age 4.7 years, and 20 with mean age 6.9 years. They were presented with the six temporal patterns in three types of context: a still-time context (using stationary lights) in which motions do not define the temporal duration; and two spatial contexts in which relative motions specify durations. One was an aligned spatial context (see Fig. 4).

Figure 4



where the beginnings and ends of the motions were spatially aligned. The other was a non-aligned context (see Fig. 5).

Figure 5



The idea behind using these different contexts was to test the prediction that as the amount of spatial data present increased, the use of this in making temporal decisions would increase (and thus mislead the children). We thus expected that the order of difficulty would run from still-time, easiest, to non-aligned, hardest. The task for the child was to interpret, by acting out in the given context, a linguistic description of a temporal pattern which corresponded to one or other of the above patterns. The patterns and the contexts were randomized over Subjects. There was also a non-verbal equivalent where the child had to try to imitate the experimenter's acting out of a given temporal pattern in a given context. This latter task was to see if the same regularities were to be observed in the children's performance in the verbal and non-verbal task -- if so, strengthening the interpretation that those regularities had to do with the way the child coded the array in relation to the given temporal pattern. Obviously there is too much data to present it all in this context (for details, see Munro, 1980; Munro & Wales, in press).

The following table gives some flavour of the results. The linguistic data were analysed using a 4-factor fixed effects design, with repeated measures on temporal pattern, context, and type of reference.

Table 1: Verbal Mean Comprehension of Each Pattern, for Relative and Categorical Reference

Age		Pattern					
Level	Reference	1	2	3	4	5	6
1	Relative	1.46	2.07	1.96	1.42	1.63	2.53
	Categorical	1.52	2.52	2.40	1.97	1.66	2.94
2	Relative	1.87	2.41	2.47	1.88	2.14	3.42
	Categorical	1.87	3.26	3.19	2.61	1.88	3.49

Each of these, plus *age*, emerged as highly significant effects, plus two significant interactions: *temporal pattern x context* and *temporal pattern x type of reference.* For the non-verbal data, *age*, *temporal pattern*, and *context* were all significant, but no interactions.

It is clear from the results that (1) as predicted, simultaneous reference is easier to comprehend than sequential for both forms of linguistic reference, and for the non-verbal; (2) categorical reference is easier than relative reference, as predicted; (3) the more possibly interfering spatial information there is on context, the harder that context makes it to process temporal information -- as predicted; (4) similar trends in verbal and non-verbal reference support the prediction that underlying the comprehension of both is a common structure, into which temporal data are translated. We have argued, and our results substantially support the argument, that this common structure is a linear, spatial one. Further support for this position is supplied by both Piaget (1969) and Clark (1971) who have shown that temporal questions can elicit spatial locative responses.

We may ask the question then: Why are spatial features sampled for temporal data? The child, it is suggested, generates a series of hypotheses about the meanings of these terms in various contexts, and evaluates each hypothesis. Spatial ordering data are likely to be sampled for two reasons. First, spatial ordering frequently coincides with temporal ordering in the child's experience. Secondly, spatial ordering has a property of tangibility and permanence not possessed by temporal relationships, and may be more salient initially.

This second study has told us a good deal more than the first, but it is, as are most experimental studies, indirect. It relies for its interpretation on inferences drawn from behavioral observations obtained in systematically manipulated and controlled contexts. It is of some interest to see if complementary inferences may be drawn from more direct questioning of Subjects regarding how they view temporal expressions.

Study III:

This study was conducted with Kerry Fairbank, with crucial analytic help from Philippa Pattison.

You may remember in the introduction to this paper a number of questions were raised concerning the validity and form of different conceptions of the time-line. This study was an attempt to address some of those questions directly. It took a leaf out of the linguists' book in supposing that there was valuable information to be gained by asking people directly questions intended to elicit answers relating to their intuitions about how their conceptions of language were organized. We intended, however, to try to be more systematic and rigorous in our methods of analysis than such linguistic exercises often are. We also needed to be simple enough so that fairly young children could relate to the task. The basic ploy was to take the *past*, *present*, and *future* as the basic reference points and ask a variety of Yes/No questions about each of them. These questions were designed to elicit information as to what the linguistic spatial framework might be that these were placed in. For example, questions were asked designed to distinguish between possible moving time and moving ego representations, such as "Can the future come to you?" or "Can you come to the future?" Not only were deictic verbs used such as *come* and *go*, but also adjectives, e.g., "Can the present be *high* (or *low*)?", or *narrow*, or *wide*, etc. Prepositional interpretations were also questioned, e.g., *in front*, *behind*; adverbs, e.g., *forwards*, *here*, *now*, etc.; demonstratives, i.e., *this* or *that*; and "state verbs" (*be*) were contrasted in many instances with "process verbs" (*go*). In all 37 questions each were asked of past, present and future. The general intention was to analyse the answers to the questions in such a way that such regularities as might structure the data could be related to alternative conceptions of the time-line. To avoid chasing accidental shadows in such data, it is important first of all to try to specify some detailed if simple models which fit different theoretical positions. It is obviously necessary to give some examples, and to do so let us concentrate attention on the verbs *come* and *go*.

These verbs are said to be deictic, in that they require for their interpretation information about the context of utterance. Either observed or assumed, it is usually necessary to know what is the spatial location of the speaker. Now if we take the present moment as the temporal index, in a manner consistent with H. Clark's notion of the canonical encounter, and using the directional relations *to* and *from*, it is possible to express both moving time and moving ego using these verbs. Thus moving ego is conceived as "coming from the past and going to the future"; while in moving time, later events are seen as "coming to" and earlier events as "going from" the speaker. These naturally occurring expressions of moving ego and moving time can be used to provide a structural framework for the generation of predictive time-line models. The use of *come* and *go* suggests which movements pivot on the speaker, *come* describing movements for which the speaker is the goal, and *go* those for which the speaker is the source. Similarly the prepositions *to* and *from* suggest the goal and source of the movement respectively. The expressions can diagrammatically represent whether a deictic elemental core provides the basis of the time-line (Figure 6). The assumptions are that the present time is indexed as "now/here", and the past and the future as "then/there" (as postulated by Traugott), and more specifically are located "behind" and "in front of" the speaker respectively (as postulated by Clark).

Figure 6

Moving Ego

	pa	pr	fu
go to			+
go from			
come to			
come from	+		

Speaker can come from past

Speaker can go to future

Moving Time

	pa	pr	fu
go to			
go from	+		
come to			+
come from			

Past can go from speaker

Future can come to speaker

Time-line models derived from moving ego
and moving time expressions

The implicational relationships which reside in the expressions are, of course, more complex: to "come from" the past implies one can "come to" the present; to "go to" the future implies one can "go from" the present. The latter implication is consistent with the deictic mapping of the time-line and hence can be incorporated into the basic model. In contrast, one cannot "come to" the present if one is already "here", i.e., at the goal that "come to" specifies. With regard to moving time, if an event can "come to" the speaker it has "come from" the future; if an event can "go from" the speaker, it can "go to" the past. These future = source, past = goal relations are not specifiable in the model, however: to speak of where the future has come or where the past goes requires a supplementary way of viewing movement on the time-line. In the deictic expression of moving time, an event "comes to" and "goes from" the speaker who is both the source and goal of the movement; this movement is the basis of the moving time model which, by implication, can also be expanded to include an additional parameter -- i.e., movement of the present from the speaker. The present can be said to "go from" the speaker because it becomes past immediately it has been experienced. In contrast, the present cannot be said to "come from" or "come to" the speakers because they are already located at the goal that "come" specifies. The expanded primary deictic models can now be schematized.

Figure 7

Moving Ego

	pa	pr	fu
go to			+
go from		+	
come to			
come from	+		

Speaker can come from past

Speaker can go from present

Speaker can go to future

Moving Time

	pa	pr	fu
go to			
go from	+	+	
come to			+
come from			

Past can go from speaker

Present can go from speaker

Future can come to speaker

Deictic time-line models for moving ego and moving time

A more elaborate set of models must necessarily evolve from the fact that speakers can cast themselves backwards and forwards to the past and future from the "here/now" of the present, and can employ extra-deictic strategies to map movement on the time-line. A speaker who is located at "here/now" and for whom the time-line concept is fully articulated, may infer the implicational relationships which hold for his/her movement in time. Where speakers at "here/now" impose their own logic to the ordering of movement, they may equate the "come/to-from" with the "go/to-from" source-goal relations: for example, to speak of being able to "go to" the future logically necessitates that one is able to "come to" the future because each expression shares the same directional preposition. This being the case, the basic framework of the above deictic models for moving ego and moving time can be expanded to include the following (Fig. 8, next page).

It is possible to go even further, following the inferential strategies which Fillmore (1971) calls "discourse deictic". These allow events to be made into deictic centres so that to speak of being able to "come to" the future, for example, might imply that the speaker has projected to the future which becomes as a consequence the deictic centre. This model has the advantage/disadvantage of allowing almost anything. The extension beyond the past-future limits of the time-line implied by these last models suggests that the past, present, and future can be conceptualized as an infinite series, or cycles, which are permanently laid out in constant order, irrespective of the speaker's location (Fig. 9, next page).

Figure 8

Moving Ego

	pa	pr	fu
go to		+	+
go from	+	+	
come to		+	+
come from	+	+	

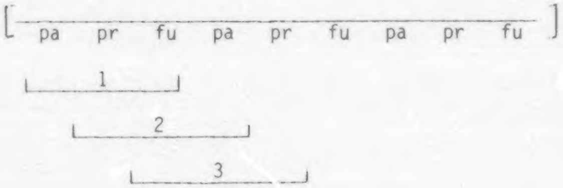
Moving Time

	pa	pr	fu
go to		+	+
go from	+	+	
come to		+	+
come from	(+)	(+)	

Moving Ego	Moving Time
Speaker can come/go to past	Past can go from speaker
Speaker can come/go to present	Present can come/go to speaker
Speaker can come/go from present	Present can go from speaker
Speaker can come/go to future	Future can come/go to speaker

Time-line models for moving ego and moving time:
extra-deictic accretions

Figure 9



B-Series representation of the time-line

If the time-line is conceived as a left to right iterative configuration (which is, in effect, an extended variation of Miller and Johnson-Laird's (1976) description of the static B-Series), as a general rule the past might be said to come before the present, the future after the present, etc., alternatively, and unlike Miller and Johnson-Laird's interpretation, if the time-line is conceived as an iterative right to left series, the future may generally be seen as initiating the order of events, because an event located in the present may have first been future and later become past. However, the picture becomes more complicated, as evinced by the temporal order which occurs in sections 2 and 3 in Figure 9. If the speaker excludes his/her own temporal location at the "here/now" of the present from the formulation of the time-line while employing discourse deictic narrative to describe it, the possible models which may evolve from the series depicted in Figure 9 must necessarily lack predictive power, because almost anything goes (and comes!) with regard to movement of ego and time; in visualising the time-line in terms of the B-Series, ego and time may be conceived as being able to "come/go" "to/from" "here/there" in infinitely variable combinations which are not constrained by canonical front-back opposition, because delineation of the series does not involve egocentric space.

However, where the speaker is located "here/now" with respect to the series (such that the B-series is translated into the dynamic A-series of Miller and Johnson-Laird (1976)), the front-back opposition enters the temporal perspective and predictions can be generated for sections 2 and 3 of the series depicted in Figure 9, just as they have been generated for section 1. For example, although the schema in section 2 in Figure 9 exhibits the same present-future source-goal relations which have been demonstrated by the models derived from the schema in section 1, in the former schema the past is located in front of, rather than behind, the speaker; it is possible that the speaker may draw on deictic as well as inferential/discourse deictic strategies to describe movement towards the past by way of the future, the latter being a projected deictic centre. Similarly, the past may be said to "come to" the speaker, again via the future which acts as an intermediary deictic centre. These models are schematized in their basic form in Figure 10, although they too can be elaborated by incorporating the strategies which were appended to the deictic models previously outlined (Fig. 10, next page).

It should be pointed out that these last models are included for the purposes of speculation only: while there is no evidence to suggest that speakers conceptualize the time-line according to these frameworks -- and certainly none appears to exist in productive temporal expressions in English -- these temporal permutations appear able to accommodate the complex transformations which inhere in the temporal perspective, e.g., tomorrow is future to now, but is pastward of next week. It should also be noted that these predictions are based on the assumption that the orientation of ego and time remains constant across series, i.e., with regard to Figure 9, ego moves forward from left to right, and time moves from right to left, front to back, through the speaker. The representation of the temporal order in Figure 5 is arbitrary, and could have been schematized in the reverse order; for the purposes of prediction, the crucial component is the direction that ego faces with respect to the temporal order. None of the models proposed in this paper accounts for individuals for whom time may run past-present-future front to back through the speaker as a general principle; nor for those for whom ego is seen as moving from future-present-past as a general principle. While the overall conceptual framework may deviate for some individuals, there are no good grounds to justify an exhaustive elaboration of the possible alternative structures which, if they do exist, are contra-indicated by

Figure 10

Section 2

Moving Ego

	pr	fu	pa
go to		+	+
go from	+		
come to			
come from			

Speaker can go from present

Speaker can go to future

Speaker can go to past

Moving Time

	pr	fu	pa
go to			
go from	+		
come to		+	+
come from			

Present can go from speaker

Future can come to speaker

Past can come to speaker

Section 3

Moving Ego

	fu	pa	pr
go to			
go from			
come to			
come from	+	+	

Speaker can come from future

Speaker can come from past

Moving Time

	fu	pa	pr
go to			
go from	+	+	+
come to			
come from			

Future can go from speaker

Past can go from speaker

Present can go from speaker

Time-line models for moving ego and moving time
generated from the B-Series

the natural expressions of the moving ego and moving time equations, at least in English. What this exploration of possible models shows is the richness of the alternatives, and how decisions between them cannot be made on simple a priori grounds.

How were the data to be analysed in order to evaluate the status of these models? The answers to each question were assigned numerical values of one and zero for "yes" and "no" respectively. The resultant binary data were then analysed by clustering and blockmodelling to reveal the inherent structure in the data. A hierarchical clustering analysis (Ward's method) was used to produce a set of homogeneous mutually exclusive and exhaustive clusters for the variables and the Subjects separately. These were then used as input for the CONCOR program, a continuous block modelling procedure (Breiger, Boorman & Arabie, 1975). The aim is to rearrange the binary matrix so that the rows (Subjects) and columns (variables) may be partitioned into relatively homogeneous groups according to boundaries inferred (in this study) from analysis of the error readings from the initial cluster outputs. These inferred boundaries define areas, or blocks, which are characterized by the density of ones or zeros, and which permit an image matrix to be obtained from the blocked data matrix. The image matrices for the several such analyses, by age group and by linguistic category, could then be compared to the different predictive models.

To obtain the basic data the 37 questions for each of the present, past, and future (in random order) were asked of three groups of Subjects, each numbering 30: of 6 years (group 1), of 9 years (group 2), and of adults (group 3). Obviously the full details of the study and its results must be given elsewhere, but the following should give some of the flavour. In the tables the sign + denotes blocks of "yes" responses, - denotes "no" responses, and ( ) indicates trends.

Consider first the adult imaged blockmodel in Table 2.

Table 2: Imaged Blockmodel Based on a Linear Characterization of the Time-Line, Derived from Group 3 Responses

ss %	1	2	3	4	5	6	7
16.7			+	-	-		+
13.3						+	+
10.0	+	+		-	+	+	(+)
13.3					-		+
10.0	-	-		-	-	-	+
13.3			-	-	-	+	+
10.0				-	-	+	+
13.4		-		-	-		+
100.0							

(See next page for details of 1, 2, 3, 4, 5, 6, 7)

(Details of Table 2, previous page.)

1. can go to fu
   fu go to you
   pr go there
   pr go behind
   pr go backwards
   pa go from you

2. pr be/go front
   pa go to you
   pa come from you

3. fu go/come from you
   pr go to you
   pr go here
   can go to pa
   pa come to you

4. can go/come from fu
   fu be/go here
   pr be there

5. fu be/go behind
   fu go backwards
   pr be behind
   pa be/go front
   pa be/go here
   pa go forwards
   can come to pa

6. can come to fu
   pr go forwards
   can go/come to pr
   pr go/come from you
   pr come to you
   pa go behind
   pa go backwards

7. fu be/go front
   fu come to you
   fu be/go there
   fu go forwards
   pr be here

7. can go/come from pr
   can go/come from pa
   pa be behind
   pa be/go there

The manner in which the moving time and moving ego equations are depicted in column 7 of Table 2 (where virtually all Subjects are in agreement) permits comparison with the predictive models formulated earlier.

Figure 11

Moving Ego

	pa	pr	fu
go to			
go from	+	+	
come to			
come from	+	+	

Moving Time

	pa	pr	fu
go to			
go from			
come to			+
come from			

Schematic representation of moving ego and moving time, derived from column 7, Table 2 (group 3)

The schemata seem to indicate that the basic time-line for adults is an amalgamation of both the moving ego and moving time equations, which contrasts with Clark's (1973) speculation that the two equations represent an essential difference in point of view. Although the characterization of moving time is less marked than for the moving ego equation, and only partially accords with the predictive models, the fact that the future is conceived as being able to "come to" the Subject is consistent with the deictic model for moving time outlined in Figure 7. In contrast, the moving ego equation appears to combine the deictic model with the accretions proposed in the extra-deictic models. Notably absent, however, is the elemental prediction that the Subject would conceive him/herself as being able to "go to" the future, which was considered fundamental to the deictic conception; in fact, movement of ego towards the future is only inferred, i.e., through movement from the present.

These schemata appear to form the backbone of the time-line concept for nearly all adults; but reference to column 6 in Table 2 indicates that for 46.6 per cent of the Subjects the time-line concept is expanded. That the two columns are intimately connected is evinced by their constitution as a major partition at an earlier level of analysis, i.e., prior to further refinement when subsequently dichotomized. Reference to the variable clusters pertinent to column 6 in Table 2 reveals that the past and present are now dynamically denoted: the past is conceived as being able to "go backwards", which reduces the cogency of Clark's (1973) hypothesis that the front face of an event leads the motion towards the past; rather, it seems that movement of the past is intimately connected with the canonical properties of ego. This is evinced, not only by the association of backward movement of the past with movement "behind" the Subject, but also the strength of the association, i.e., by the fact that the two variables were internally tied within the original blocked data matrix. The same internal relationship can be demonstrated for the dynamic properties (forward/front) attributed to the future in column 7, Table 2. The fact that temporal movement appears allied to the properties of ego indicates that Clark's hypothesis that the moving time equation represents a different perspective of the front-back terms is tenuous.

Combining the schemata for moving ego from columns 6 and 7 in Table 2 can be seen to approximate the predictive model in Figure 8, i.e., for almost half the adult subjects for whom columns 6 and 7 were tied in Table 2, an overall propensity is indicated for movement of ego to and from the present, which was predicted in Figure 8, movement to the past and from the future being non-existent. This implies, perhaps, that the Subjects have operated within a conceptual framework in which the past and future represent the outer limits of temporal experience, unlike the schemata which was predicted by discourse deictic and those derived from the B-Series in Figures 9 and 10.

However, the schema depicted in Figure 12 cannot be fully explained by the proposition that logical strategies would be built on to the basic deictic framework, as was suggested as the basis of the model for moving ego depicted in Figure 3. Clearly other strategies were operant which may account for the partial representation of movement of ego towards the future and the movement of the future towards ego in the moving time equation, as has already been suggested.

Figure 12

Moving Ego	pa	pr	fu
go to		+	
go from	+	+	
come to		+	+
come from	+	+	

Moving Time	pa	pr	fu
go to			
go from		+	
come to		+	+
come from		+	

Superimposed Schemata Derived from Columns
6 and 7 in Table 2 (group 3)

Turning now to the 9-year-olds, Table 3 summarizes their data.

Table 3: Imaged Blockmodel Based on a Linear Characterization of the Time-Line, Derived from Group 2 Responses

ss %	1	2	3	4	5	6
16.6				+	-	+
6.7			+	+	-	(+)
13.3	-	+		+	-	+
6.7				+		
20.0				-	-	+
26.7		+	-	-	-	+
10.0			-	+	-	+
100.0						

(See next page for details of 1, 2, 3, 4, 5, 6)

(Details of Table 3, previous page.)

1. can go to fu
   fu go to you
   can go to pr
   can go from pr
   can come from pr
   pr go to you
   pr come from you
2. fu come to you
   pr go from you
   pr come to you
   pa come from you
3. can go from fu
   fu go from you
   fu be/go behind
   pr be/go behind
   pr go backwards
4. pr be/go front
   pr go forwards
5. can come from fu
   fu go backwards
   fu come from you
   fu be/go here
   pr be/go there
   can go/come to pa
   pa go/come to you
   pa be/go front
   pa go forwards
   pa be/go here
6. can come to fu
   fu be/go front
   fu be/go there
   fu go forwards
   pr be/go here
   can come to pr
   pa go backwards
   pa be/go there
   can go/come from pa
   pa be/go behind
   pa go from you

Although a major partitioning can be discerned in column 4, it can be seen that these variables pertain only to the present; furthermore, the variables include only frontal terms, but this conception of the present is incomplete as will be discerned by analysis of subsequent blockmodels. The most pertinent aggregation of "yes" blocks occurs in column 6 where, for most of the children, the time-line is clearly delineated according to the front-back opposition which was noted for the adults. In addition, the proximal-distal relationships defined by the adverbs "here" and "there" are also expressed by the children. Also interesting is the fact that the children have employed the same relations as the adults to describe the respective forward and backward movement of the future and past -- again hinting that Clark's (1973) hypothesis that the movement of time is related to the properties of the event rather than ego is untenable, at least as a general principle.

The manner in which the moving ego and moving time equations have been conceptualized by the 9-year-olds can be discerned in Figure 13 (next page). Although the equations derived from column 6, Table 3, are conjunctively represented for the children (and are thus essentially different points of view, as Clark (1973) has speculated), the patterns deviate: column 2 indicates that the moving ego equation is more elaborate for 40 per cent of the children. Appended to the elemental core exhibited in column 6, Table 3, the elaborated equation can be schematized as in Figure 14 (next page).

Three of the entries in Figure 14 coincide with the predicted deictic model in Figure 7, i.e., the past and present are conceived as being able to "go from", and the future as being able to "come to", the Subject at the deictic centre. Since the predicted deictic framework is fully constituted in the schema, the suggestion that it is developmentally fundamental to the time-line formulation appears tenable. The picture deviates from the adult conception: only the entry pertaining to the future was included in the basic adult framework; and movement occurred only in relation to the present in the expanded adult equation. In fact, the moving time equation was less manifest for the adults than these children. Interestingly, the past has been seen by the children as being able to "come from" the deictic centre, whereas the adults had applied the same relation to express movement of the present. Again, the entry is puzzling, given the source-goal confusion implied in the relation, and warrants explanation.

Figure 13

Moving Ego

	pa	pr	fu
go to			
go from	+		
come to		+	+
come from	+		

Moving Time

	pa	pr	fu
go to			
go from	+		
come to			
come from			

Schematic representation of moving ego and moving time, derived from column 6, Table 3 (group 2)

Figure 14

Moving Time

	pa	pr	fu
go to			
go from	+	+	
come to		+	+
come from	+		

Schematic representation of moving time, derived from columns 2 and 6, Table 3 (group 2)

It appears that the time-line is a simpler construction for the children than was evident for the adults. Column 5, Table 3, shows a strong aggregation of "no" blocks for all but 6.7 per cent of the 9-year-olds, which indicates that the more complex relations associated with the temporal perspective have been rejected by the children as appropriate ways of operating on the time-line. That the group 2 time-line characterization is less complex and also forms the substructure of the adult framework can be more readily discerned by comparison of Table 3 with Table 4, in which the hierarchical variable clustering which occurred for the group 2 children was superimposed on to the adult (group 3) schema. Column 6 in Table 4 shows that the elemental core of the time-line which was evident for the 9-year-olds underpins the adult formulation for almost all Subjects. The most notable differences between the two Subject groups with respect to the variable cluster pertinent to column 6 (Tables 3 and 4) consolidate the previous findings, i.e., the major disparities concern the ability of the past to "go from" ego (adults 40%; children 77%), and the ability of the present to "go here" (adults 55%; children 90%). This evidence accords with the earlier suggestions that the adults were more prone to construe the past in static terms (cf. the future and present) than were the children, and were more facile at distinguishing between the dynamic and static expressions of the deictic adverb pertaining to the present.

Table 4: Imaged Blockmodel Based on the Group 2 Hierarchical Variable Clustering which was Superimposed on to Group 3 Responses

ss %	1	2	3	4	5	6
16.7	(+)	+		-		+
13.4	+	+		(+)		+
10.0	+	+	(+)	+		+
13.3			-			+
10.0		-	-	-	-	
13.3			-		-	+
10.0	+	(+)		+		+
13.3				-	-	+
100.0						

1. can go to fu
fu go to you
can go to pr
can go from pr
can come from pr
pr go to you
pr come from you

2. fu come to you
pr go from you
pr come to you
pa come from you

4. pr be/go front
pr go forwards

3. Can go from fu
fu go from you
fu be/go behind
pr be/go behind
pr go backwards

5. can come from fu
fu go backwards
fu come from you
fu be/go here
pr be/go there

5. can go/come to pa
pa go/come to you
pa be/go front
pa go forwards
pa be/go here

6. can come to fu
fu be/go front
fu be/go there
fu go forwards
pr be/go here
can come to pr

6. pa go backwards
pa be/go there
can go/come
from pa
pa be/go behind
pa go from you

Not surprisingly, the results for the youngest group, the 6-year-olds, are much less internally coherent. There were nine natural clusterings of the variables. To save time here, Table 5 represents the imaged blockmodel for group 1 in the immediately comparable clustering of the variables of the 9-year-olds.

Table 5: Imaged Blockmodel Based on the Group 2 Hierarchical Variable Clustering which was Superimposed on to Group 1 Responses

ss	1	2	3	4	5	6	
13.3						(+)	NC(1)
6.7		-	-		-		NC(1)
13.3			-	+	-	+	
10.0			+	+		+	
23.3		+	+	+		+	NC(2)
16.7	-	-		-			
6.7		-	-	-			
10.0		-	-	-			NC(2)
100.0							

1. can go to fu
fu go to you
can go to pr
can go from pr
can come from pr
pr go to you
pr come from you

2. fu come to you
pr go from you
pr come to you
pa come from you

3. can go from fu
fu go from you
fu be/go behind
pr be/go behind
pr go backwards

4. pr be/go in front
pr go forwards

5. can come from fu
fu go backwards
fu come from you
fu be/go here
pr be/go there

5. can go/come to pa
pa go/come to you
pa be/go front
pa go forwards
pa be/go here

6. can come to fu
fu be/go front
fu be/go there
fu go forwards
pr be/go here
can come to pr

6. pa go backwards
pa be/go there
can go/come from pa
pa be/go behind
pa go from you

It can be seen from Table 5 that there is conceptual overlap between the future and the present for approximately 35 per cent of the 6-year-olds (column 3). However, reference to column 6, Table 5, shows that the elemental time-line evident in the 9-year-olds appears represented in approximately 60 per cent of the 6-year-olds. The data which most closely accords with those of the older children includes deictic movement of ego from the past ("can come from the past") and its implicational relation ("can come to the present"). In Table 5 (NC) refers to those children who were not conservers of number, in the Piagetian sense.

The distribution of their data suggests that the connection between the development of concepts of number and linguistic time may be oblique.

This is a rather cursory presentation of the results but they may be summarized as follows.

1. The proximal/distal distinction is general to all groups.

2. For the 9-year-olds and the adults front = future and back = past. For the 6-year-olds, when systematic, past = behind is the prior organizing principle. This suggests that lexical marking is not the fundamental principle of organization (see also Wales (1979) and Tanz (1980) for a similar general result for spatial deixis).

3. Both moving ego and moving time are conjunctively represented, though the latter is less fully articulated.

4. While 2 and 3 dimensions are not lexicalized in temporal expressions in English, they were used by most Subjects in all three groups though with varying degrees and consistency as compared to the front/back opposition. In general it seems that the younger children are using them more perhaps because they know of the relevance of the spatial metaphor but have yet to work out the appropriate dominant axis. Thus there seems to be a simplification principle that the children must acquire in developing the space to time mapping in language.

5. Consistent with the space and time "coincidence" of expressions, it is not surprising that the deictic predictive models fit the data quite well. The major mismatch lies with the conception of the future. Following a suggestion of Lynn Wales, this may be because the future is more associated with linguistic mood and thus expectation, whereas the past may be more associated with linguistic aspect and rooted in memory. (For detailed discussion of deixis, see Lyons, 1977.)

Thus it may be because spatial cues are salient -- their salience embedded in innate organizing principles (see Day, this volume) -- plus the effect of experience mediated by memory, that results in the apparently surprising use of spatial expressions as temporal ones.

Acknowledgements

I am grateful for the generosity and help of Kerry Fairbank, John Munro, and Philippa Pattison; and to the ARGC (Australian Research Grants Committee) for their support.

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THE READING STRATEGIES OF CHILDREN WITH SPELLING DIFFICULTIES

Beryl E. McKenzie and Mary E. McCorriston
La Trobe University

Children with specific spelling disability are those who cannot spell as well as they read, although their intelligence is within the normal range. The inability to output the correct sequence of letter strings corresponding to English words considerably limits written communication and constitutes a serious handicap in some circumstances. While the incidence of children who read well but spell poorly is not high, a study of their difficulties is fruitful since the factors of spelling ability and degree of language experience can be unconfounded. In only a few studies have the separable effects of reading and spelling ability been assessed. It has been noted that unexpectedly poor spellers make different kinds of spelling errors from those poor spellers who also have difficulties with reading (Frith, 1980; Nelson & Warrington, 1974).

The observation that they exhibit a higher proportion of phonetically acceptable errors (REDELY rather than READILY) suggests that, unlike poor readers-poor spellers, their difficulty lies beyond the stage of analysis of constituent phonemes in a word. Like good readers who spell well, they output a sequence of letters which accurately conveys the sounds of the word. Thus they are capable of generating a phoneme-grapheme correspondence, but not the traditionally accepted transcription. Good spellers also make mistakes of this kind for words with which they are not familiar. However, from the range of phonetically plausible graphemes corresponding to given phonemes, they are more likely to choose those which are conventionally correct.

Frith (1980) has suggested that different reading strategies may account for the differences between competent spellers and poor spellers when both groups read at an age appropriate level. When "reading by eye"--reading for meaning--the two groups cannot be distinguished. Poor spellers, however, have difficulties when the task requires conversion of print to sound. Such tasks include judging rhyming word pairs and reading mis-spelled words that preserve sounds (DEVELOPING) and those that do not (DEVOLEPING). Poor spellers do not perform as well as competent spellers on these tasks. Frith suggests that poor spellers use only partial cues relating to the words that they read. They read by eye rather than by ear, without paying attention to the letter by letter structure of words. This strategy does not hinder their recognition of words or comprehension of meaning. It does, on the other hand, hinder their acquisition of knowledge of letter sequences and hence their ability to output correct letter strings. McCorriston & McKenzie (1979) also observed that unexpectedly poor spellers were weak in the recognition of morphological relationships in spoken English. Since these patterns are frequently more obvious in the written than in the spoken word (e.g., SIGN, SIGNAL), it is possible that reading by partial cues is not conducive to the development of knowledge of morphophonemic rules. For these poor spellers, there is a dissociation between the reading and spelling processes. Good spellers, by attending to both the phonological aspects and the visual aspects of words, acquire incidental, although not necessarily explicit, knowledge of orthographic rules. Frith refers to these strategies as reading by partial cues and reading by full cues.

Barron (1980) also studied reading strategies in good and poor readers, graded without reference to their spelling ability. He varied visual-orthographic and phonological information in a lexical decision task. Visual orthographic information was manipulated by choosing words with either high or low summed single letter and bigram positional frequency, i.e., words varying in their positional and sequential constraints on letter strings. Phonological information was manipulated by choosing words in which the application of common grapheme-phoneme correspondence rules yields either a correct or an incorrect phonological representation (e.g., SWEET, SAID). These may be called regular and irregular words. The good readers, but not the poor readers, exhibited a regularity effect: They responded faster on the regular words. The poor readers, but not the good readers, exhibited a frequency effect: They were faster on high positional frequency than on low positional frequency words. Additional evidence led Barron to suggest that the regularity effect in the good readers was brought about by the faster generation of a phonological code. These results are consistent with those of Frith, although it might have been expected that the good readers would have shown a frequency effect. Her findings would also lead to the prediction that good readers-poor spellers would not show a regularity effect because of their difficulty in converting print to sound, but that their reliance on holistic visual patterns may produce a frequency effect.

Barron's method was adapted to examine the reading strategies of good readers-good spellers, good readers-poor spellers and poor readers-poor spellers. Two tasks were used: A lexical decision task, "Is this a word or not a word?", and a phonemic decision task, "Does this sound like a word or not?" In the latter task, the aim was to force phonological processing since much of the evidence points to the difficulties which unexpectedly poor spellers have when converting print to sound.

Method

The Schonell Graded Word Reading Test R1 and Spelling Test S1 (Schonnell & Schonell, 1965), and the Otis Intermediate Test (Form C.D) were given to 110 Grade 6 children from two local primary schools. The children were aged from 11 to 12 years. Three groups of 10 subjects each were selected with the characteristics listed in Table 1.

Table 1
Sex, mean reading, spelling and intelligence quotients for the three experimental groups. Standard deviations are given in brackets

	Group A Good readers Good spellers	Group B Good readers Poor spellers	Group C Poor readers Poor spellers
Reading	113 (8.7)	109 (5.5)	90 (3.8
Spelling	112 (9.7)	92 (6.1)	88 (4.7
IQ	118 (8.9)	111 (9.3)	107 (5.4)
Sex	F6 M4	F5 M5	F2 M8

Group B was the group of interest. Although, like the other groups, these children were considered to be within the normal range of intelligence, they read as well as the children of Group A, but spelled as poorly as those of Group C. Each child was tested on both the lexical decision task and the phonemic decision task.

For the lexical decision task, Barron's lists of words were used (Barron, 1980). These lists varied in regularity, either regular or irregular, and in letter positional frequency, either high or low. Lists of matching non-words were generated by changing one letter of each real word, preserving word length and letter positional frequency. All the non-words were pronounceable and the location of the changed letter was varied across letter position in the word. Lists were also matched for word frequency. There were thus eight lists of 30 items each. Stimulus items were printed in lower case and projected at eye level on a screen 6ft. in front of the subjects. Words and non-words were presented in random sequence and the child's task was to decide as quickly and as accurately as possible whether the item was a word or not. A decision was indicated by pressing a lever to the right or left. The position of the "yes" "no" labels was reversed for half the subjects. Prior to testing, subjects were given pretraining until attaining five consecutively correct responses. Pretraining continued, with subjects being encouraged to respond as quickly as possible, until a plateau in response latency was achieved. During testing, feedback as to the correctness of response was given. The dependent variables were response latency and proportion of errors.

For the phonemic decision task, an additional list of 60 pseudohomophones was constructed. These consisted of non-word letter strings which were pronounced the same as English words (e.g., BURD, BLUD, GROE) and which were of the same length and letter positional frequency as the words and non-words included in the test. The word frequency of their homophonic, real-word counterpart matched that of the real test words. The pretraining and testing procedures were the same for both tasks and the testing order was counterbalanced over subjects.

Results

Lexical decision. In the lexical decision task, all three groups of subjects were faster at detecting words of high positional frequency (707 msec) than words of low positional frequency (741 msec), $F(1,27 = 15.39$, $p < .001$. However, Groups B and C, the poor spellers, made more errors than Group A. All error scores were submitted to an arcsin transformation prior to statistical analysis. The mean transformed error scores for Groups A, B, and C were .40, .55 and .57 respectively, and this main effect for groups was significant $F(2,27) = 4.41$, $p < .05$.

For non-words the same pattern of responding was evident. Non-words with high positional frequency were detected faster (978 msec) than those with low positional frequency (1003 msec), $F(1,27) = 4.93$, $p < .05$, and Groups B and C made more errors than Group A, the mean transformed scores being .87, .83, and .52 respectively, $F(2,27) = 4.14$, $p < .05$.

Thus for all groups in the lexical decision task, words of high positional frequency were responded to faster than those of low positional frequency, and poor spellers regardless of reading status, made more errors than the good spellers.

Phonemic decision. The more interesting results were obtained in the phonemic decision task, in which the variables of regularity and frequency interacted with reading and spelling ability. It may be noted that for real words, Group B was as fast and as accurate as Group A, while Group C was both slower and less accurate. The mean latencies for Groups A, B, and C were 709, 713, and 850 msec respectively, $F(2,27) = 3.7$, $p < .05$, and the mean transformed error scores were .33, .36, and .53 respectively, $F(2,27) = 5.14$, $p < .05$. Items with higher positional frequency were responded to faster (744 msec) than those with lower positional frequency (771 msec), $F(1,27) = 14.24$, $p < .001$. However, this main effect for frequency was moderated by reading and spelling status, as may be seen in Fig. 1. The groups x frequency interaction was significant, $F(2,27) = 5.41$, $p < .05$.

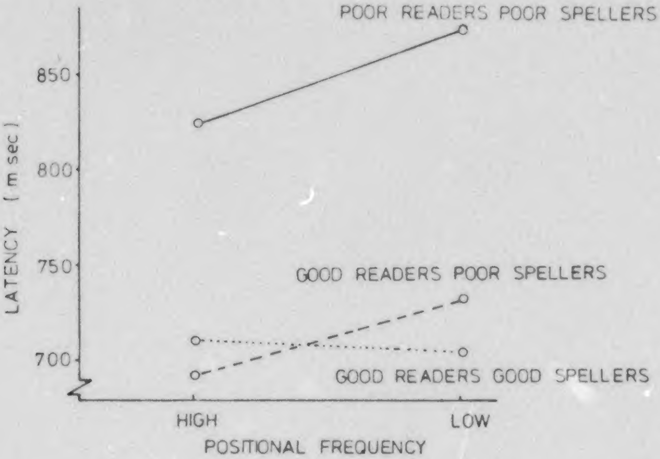

Fig 1

Figure 1: The mean latencies for words of high and low positional frequency for the three experimental groups.

The effect of positional frequency was evident for both groups of poor spellers but not for the good spellers. With respect to the visual orthographic information provided by positional frequency of letters within words, the performance of Group B subjects was similar to that of Group C subjects, although faster and more accurate. When asked to judge whether a visually presented letter string sounded the same as an English word, their response was slower for words comprised of letters of low positional frequency. These results are consistent with the prediction derived from Frith's hypotheses. Even when a task has strong demands for phonological encoding, visual cues are still effective. For the good spellers whose visual representation in the lexicon is extensive and detailed, positional frequency has little effect on response time. For Group B subjects however, the visual representation in the lexicon is not so detailed. High positional frequency words are comprised of much redundant information with regard to letter sequence. On these words, Group B subjects were as fast as those of Group A. The redundancy of letter sequence is markedly reduced in low positional frequency words. In order to maintain their high level of accuracy, subjects in Group B seem forced to adopt a more careful search strategy.

With regard to regularity, however, the response of Group B subjects was more similar to that of Group A subjects. Neither group exhibited the strong regularity effect that was evident for subjects in Group C, as may be seen in Fig. 2. The interaction of groups and regularity was significant, $F(2,27) = 3.37$, $p < .05$.

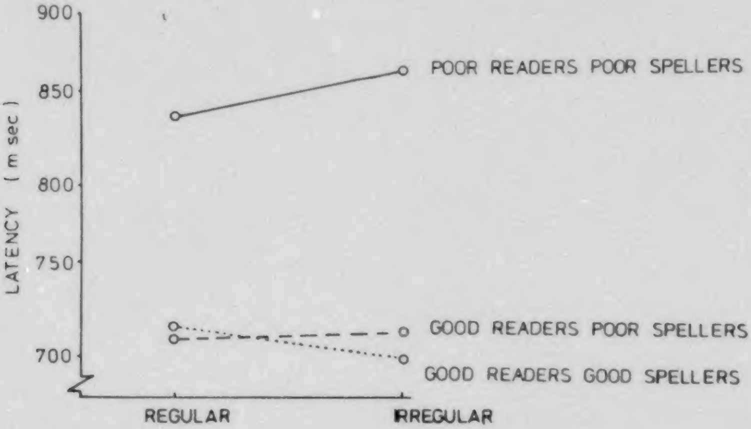

Figure 2: The mean latencies for regular and irregular words for the three experimental groups.

For poor readers, it takes longer to decide that a visually presented letter string of an irregular word sounds the same as an English word than to make that decision for a regular word. This is not surprising since their knowledge of phoneme segmentation and grapheme-phoneme correspondence rules is known to be poor (Bradley & Bryant, 1978; Mark, Shankweiler, Liberman & Fowler, 1977). No regularity effect was predicted for Group B, since they have been shown to have difficulties with transforming print to sound, yet be well practiced and fast with holistic visual analysis. It is somewhat surprising, however, that the good spellers of Group A did not exhibit a regularity effect as would be predicted on the basis of both Barron's and Frith's results. Our results suggest that, even although they are tuned to perform a phonological analysis, their complete visual knowledge of regular and irregular words allows the faster visual route to the lexicon to be successful.

With regard to non-words, however, very different results are obtained. There was no significant difference between the groups in response latency; all groups took longer to decide that the letter string of a non-word did not sound the same as an English word, as did a word or a pseudohomophone. The accuracy of Group B subjects was reduced so markedly that their error rate was even higher than that of Group C subjects. The mean transformed error scores for Groups A, B, and C were .82, 1.32, and 1.12 respectively, $F(2,27) = 6.22$, $p < .001$. The task was obviously a difficult one for all subjects since both latencies and error rates were higher than in the lexical decision task. When a non-word is presented visually and the subject has to decide whether it sounds the same as a real word, the only way to achieve a correct response is to attend to the letter by letter sequence of the item. Group B subjects have even more difficulty than do Group C subjects in performing such an analysis.

Conclusion

In the phonemic decision task requiring analysis of how a letter string sounds, the manipulation of visual orthographic and phonological information differentially affected the performance of subjects according to their facility in reading and spelling. This manipulation was not effective in the lexical decision task. In the former, there is greater emphasis on phonological processing than in the latter. If a group of subjects has more pronounced weaknesses in phonological than in visual processing, group by strategy interactions are more likely to be detected.

When asked to judge the phonemic similarity of a visually presented item to a real word, good readers-poor spellers are as fast and as accurate as good spellers on real words. But this similarity in level of performance is achieved in different ways. Poor spellers are more influenced by the redundancy in the letter sequence of a word than are good spellers. Neither group is strongly influenced by the regularity of grapheme-phoneme correspondence rules. These results are consistent with the hypothesis that the poor spellers are using a predominantly visual strategy in reading. When the constraints of a task are such that attention to the letter by letter sequence of a word is necessary, good readers-poor spellers can no longer rely on a holistic visual strategy. They are forced to attend to the sound corresponding to each letter or letter cluster. In this analysis they make many errors.

In summary, the strategy of reading of good readers-poor spellers differs from that of competent spellers. Their preferred strategy is to attend to the visual characteristics of words and they do not perform well when a task demands phonological encoding. It is likely that this strategy of reading reduces the opportunities of acquiring incidental knowledge about orthographic rules and the letter-by-letter structure of words. Their ability to output a correct orthographic transcription is impaired even although they make predominantly phonetically acceptable spelling errors. When matching the proposed spelling against the representation in the lexicon, the phonetic structure is preserved but the detailed letter-by-letter sequence is not.

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DICHOTIC LISTENING IN POOR READERS: A REPLICATION WITH DEVELOPMENTAL PERSPECTIVE

Phillip Dermody, Kerrie Mackie and Kim Whyte
National Acoustic Laboratory, Sydney

In a recent series of studies Tallal and her colleagues (Tallal & Piercy, 1973; Tallal, 1976) have reported what could be a specific impairment in processing rapid auditory signals which is associated with severe language impairment in children. Another series of studies (Dermody, 1976; Dermody & Noffsinger, 1976; Dermody & Mackie, 1980; Tobey et al., 1979) have reported another specific deficit which is observed in the dichotic listening performance of children with language disabilities.

Dichotic testing can be explained by reference to Figure 1. This shows the typical dichotic paradigm using CV syllables as stimuli. If the subject is required to indicate the two stimuli that were presented four response classes are possible. The subject can obtain a single correct response for either the left or right ear; a double correct response if he gets both items correct, and a double incorrect response if he gets both items incorrect.

Traditionally, interest in dichotic listening research has been directed to the occurrence of single correct responses because these show the usually observed ear effects: namely that the right ear usually obtains higher scores than the left ear. This effect, known as the right ear advantage (REA), is associated with speech processing in the left cerebral hemisphere.

While our initial interest in dichotic listening was to investigate the REA in language disordered groups (Dermody, 1976), we have usually found, at least in older children, normal REAs in such groups. This conclusion is supported by several independent studies (Sobotka, 1973; Springer & Eisenson, 1977; Tobey et al., 1979). However we have also found consistently poorer performance by language disordered groups for the "both correct" response class (Dermody, 1976; Dermody & Noffsinger, 1976; Dermody & Mackie, 1980).

We were reluctant to call this result a "specific" dichotic effect until we completed a study and demonstrated that if two CV stimuli close together in time (90 msec. onset differences) were presented monotically to a group of poor readers, they obtained as many both correct trials as good readers; if however the same stimuli were presented dichotically their two correct response performance showed significant and dramatic reduction (Dermody & Mackie, 1980). A further analysis of this data indicated that this effect was not obviously related to auditory discrimination difficulties by the LD group or to any differential ear effects.

The present study considers this phenomenon in a group of children chosen on the same criterion as an earlier investigation by Dermody and Mackie (1980), but which also includes children from a wider age range.

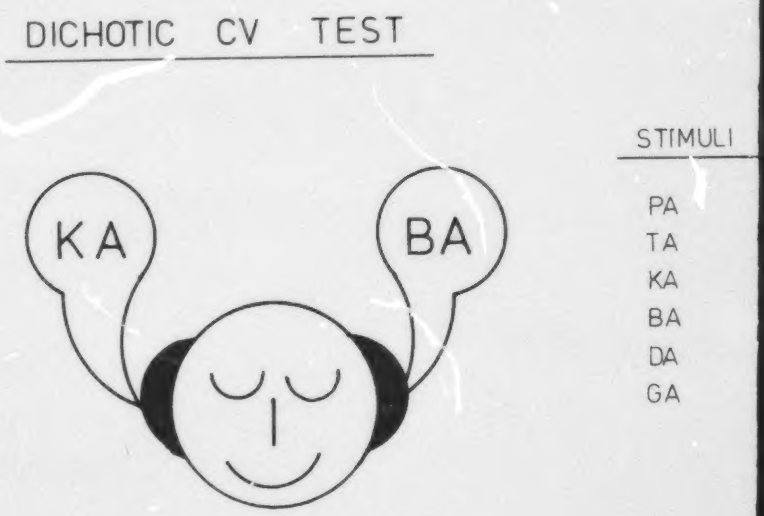


Figure 1: Dichotic CV recall task.

Method

The children were chosen from Classes 3, 4, and 6 of a suburban Sydney school. Teachers of the three classes were asked to rate their students for language abilities. From this data 10 children were chosen from each class--five rated as poor and five rated as good in language skills. Children with an ESL background were excluded.

The mean age of the 6th class group was 11 years 8 months, for the poor readers (two boys, three girls), and 11 years 5 months for the good readers (two boys, three girls). The poor and good reader groups from 4th class each had two boys and three girls with mean age for each group of 9 years 8 months. The 3rd class poor readers consisted of three boys and two girls with a mean age of 8 years 4 months and the good reader group had two boys and three girls with a mean age of 8 years 4 months. The 30 children were given a group reading test (Gapadol Reading Comprehension--McCleod and Anderson, 1972) which confirmed a significant reading level difference between the two groups.

The production of the dichotic tapes has been described elsewhere (Dermody, Mackie & Katsch, 1978). In brief, two dichotic tapes were constructed that consisted of 30 randomised pairs of natural speech using the CV items / ba, da, ga, pa, ta, ka / arranged to provide all possible pairings of different consonants and counter-balanced for channel of presentation (30 pairs per tape, a total of 60 stimuli).

Tapes were generated from digital representation under computer control. This provided onset alignment better than five microseconds, an audio range of 12 kHz and a signal-to-noise ratio for the tape better than 55 dB.

The dichotic tapes were presented via a specially constructed portable speech audiometer at 80 dB SPL. Calibration of the system was checked at the beginning and end of each test session. The testing was carried out in a quiet room using sound attenuating earphones.

Before the test session it was determined that each child could easily read and repeat the six stimulus alternatives displayed in front of him; accurately respond to each stimulus presented binaurally; and complete five practice dichotic trials with appropriate responses. Pure tone audiogram and tympanometric results were also obtained for each child and indicated normal results for both groups.

After the instructions and practice trials each child reported that he understood the task. It was emphasised in the instructions that: two responses were mandatory; that two identical items never occurred on the same trial; that he should guess if unsure of one or both of the items. After each pair presentation the experimenter waited for two responses. This resulted in some variability in test session times but in general the testing lasted 20 minutes.

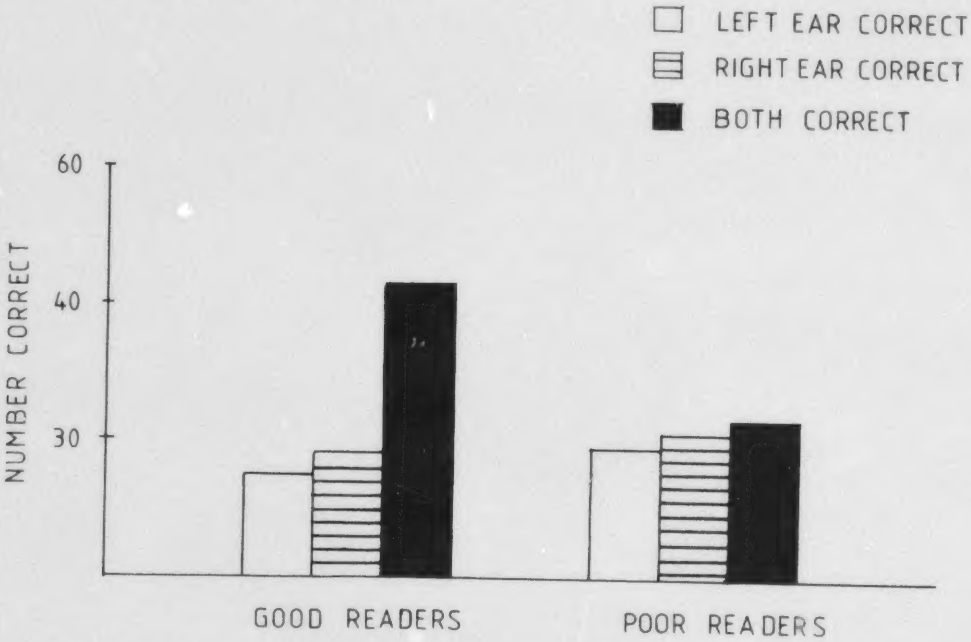


Figure 2: Dichotic score for CV items presented with simultaneous onset. Average results for 8-, 9- and 11-year-olds.

FIGURE 3 FREQUENCY HISTOGRAMS FOR BOTH CORRECT TRIALS FOR 8 YEAR OLDS

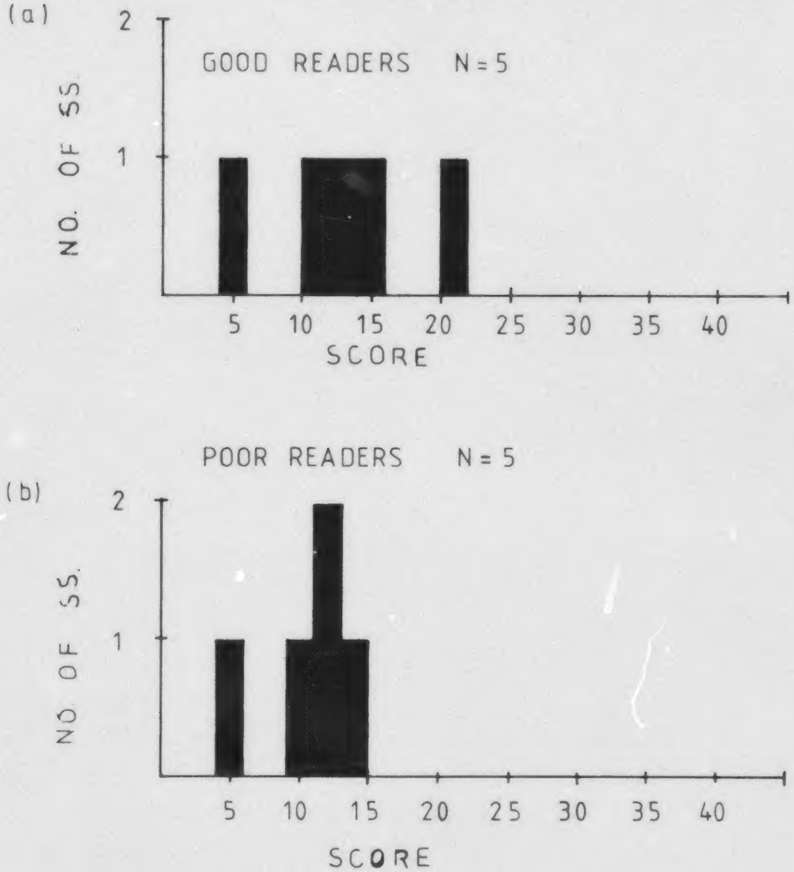


FIGURE 4 FREQUENCY HISTOGRAMS FOR BOTH CORRECT TRIALS FOR 9 YEAR OLDS

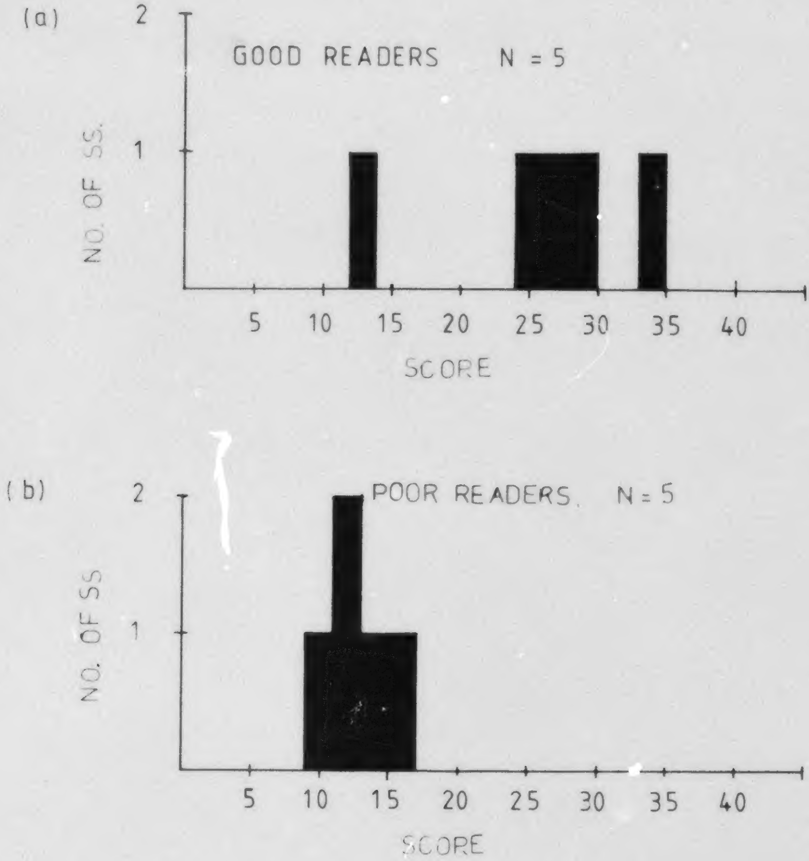
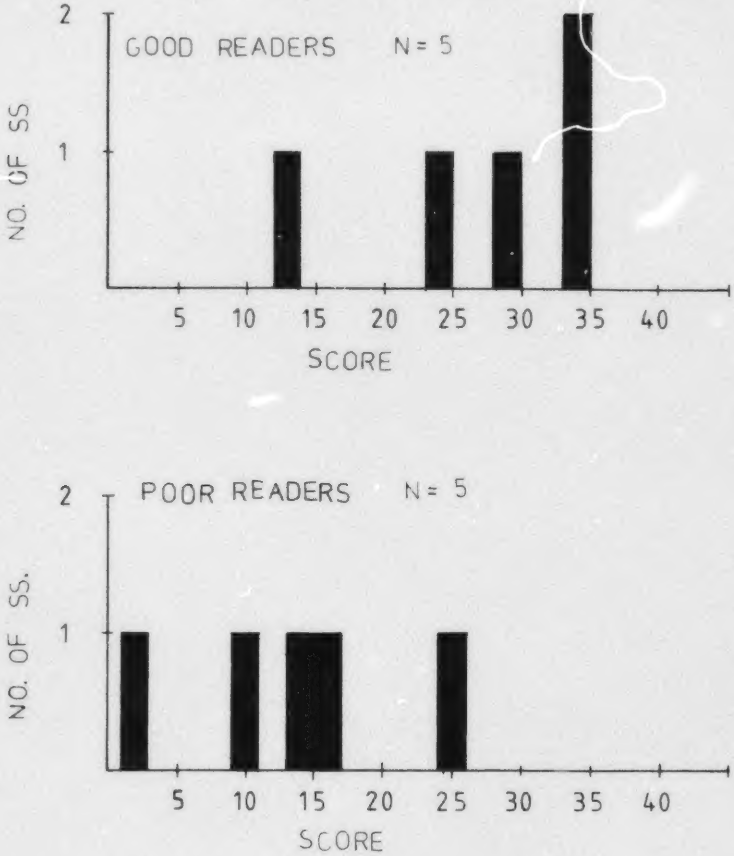


FIGURE 5 FREQUENCY HISTOGRAMS FOR BOTH CORRECT TRIALS FOR 11 YEAR OLDS



Results

Figure 2 shows the overall mean results for the good and poor reader groups. A planned comparison between each of the means was carried out. There was no significant difference between the right ear scores for the two groups. The difference between the groups for the left ear score is significant ($p < 0.05$) with the poor readers performing better than the good readers. However the good readers perform considerably better than the poor readers for both correct trials and the difference is statistically significant ($p < 0.01$).

This indicates that it is only the double correct performance which indicates a processing deficit in the poor reading group. In order to investigate this effect in more detail we analysed the double correct scores on an age by age basis.

Figure 3 presents the number of 8-year-old children who obtained a particular score on the dichotic task. As the means would suggest there is no difference between the performance of the two groups when analysed statistically.

Figure 4 shows the double correct responses for the 9-year-old children. In this case there are two almost non-overlapping distributions. The difference between the means is significant at $p < 0.025$ level.

Figure 5 shows the same data for the 11-year-old children. The distribution is similar to the 9-year-old children but there is a greater spread of scores between the groups. The difference in the means just fails to reach significance at the $p < 0.05$ level.

Discussion

The overall results for the present study support data reported previously by a number of investigators (Dermody & Noffsinger, 1976; Sobotka, 1973; Tobey et al., 1979) and indicate that dichotic performance for the two response CV recall paradigm demonstrates significant differences for children with language disabilities compared to normal reading controls. However, the present study also demonstrates the possible role of developmental effects in this finding.

Berlin et al. (1973) noted that developmentally the REA seems fixed by age five but that the ability to recall two simultaneous stimuli increases with age from 5 to 13 years. The authors suggest that their data reflects an increasing channel capacity for the children in their study. They also noted that channel capacity was unrelated to the REA in dichotic listening.

The notion of channel capacity is interesting because of its possible relation to the acquisition of language skills. In a previous investigation (Dermody & Mackie, 1980) we tried to define the notion of channel capacity in more precise ways. We suggested that it should probably not be seen only as a temporal processing factor because differences between the groups are a dichotic effect which do not hold up in monotic presentation. The role of stimulus encoding and retention problems for items rapidly presented might be implicated.

The present data indicates that at eight years the dichotic processing deficits are not seen in the poor reader group. This is obviously the result of the equally poor performance for both correct trials by the controls. However by 9 and 11 years dramatic differences emerge. In fact, for the poor reader group in all the age groups there appears to be very little change in capacity to successfully report both items on dichotic trials.

Unfortunately there is no indication how the processing deficit observed in dichotic trials relates to language acquisition, Nor is it likely that such a connection will be a simple one. However the demonstration of another consistent and specific auditory processing problem in children with language disabilities does support the potential value of the investigation of auditory processing factors underlying language.

In conclusion, the present study:

1. Provides additional support for an auditory processing deficit on dichotic tasks by poor readers;
2. Indicates that while children with average reading skills improve their processing of simultaneous stimuli as they get older, poor readers do not.
3. Suggests that the continued investigation of auditory processing deficits noted in children with language disabilities might lead to a better understanding of how inefficient processing relates to language disabilities.

Acknowledgement

The authors wish to thank the N.S.W. Department of Education and particularly the staff and students of Bilgola Plateau Primary School for their help and cooperation with this research.

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THE LINGUISTIC EXPERIENCE OF SLOW LANGUAGE LEARNERS[1]

Toni G. Cross
Institute of Early Childhood Development

It is now possible to claim that detailed investigation of children's linguistic experiences is as essential to a full understanding of the language learning process as investigation of child language itself. In fact, one can argue that a full characterisation of parental speech as input at various stages during development should actually take priority over descriptions of child speech and comprehension, on the grounds that it is necessary to discover details about the language the child is acquiring before we draw conclusions about how the child is going about the process of learning it. Not to do so is to risk imputing to an innate linguistic competence constraints that may actually be imposed on the learning process by the special nature of the language children hear.

However, while it is widely accepted that adult caregivers and older children substantially modify their language to young children, it has not yet been possible to establish direct relationships between this specialised linguistic input and the process of language acquisition. Experimental studies of various features of parental speech have generally produced conflicting conclusions about their roles in language development. Beyond this, such studies suffer from the limitation that effects (or non-effects) produced in the laboratory may have little relevance to the way the developmental process operates in nature. This problem is underlined by research conducted in natural settings which suggests that children themselves, in several ways, play major roles in determining the linguistic and pragmatic adjustments made by parents. In particular, it has been shown by Newport (1976), Cross (1977), and Ellis and Wells (1980) that, during early development it is the child's growing communicative and linguistic capacity which accounts for the major proportion of the variance on many mothers' speech features; and yet laboratory-style investigations have inevitably neutralised the children's abilities to influence their own linguistic input and learning experiences.

On the other hand, the few studies which have investigated this relationship in naturalistic settings (by means of analysis of observational and tape-recorded data) have also produced ambiguous conclusions.

The first of these naturalistic studies was conducted by Brown, Cazden and Bellugi (1969). On their own admission, their results were difficult to interpret, since they summed both measures of child speech and measures of parental speech, taken concurrently over several stages of development. Furthermore, their simple correlational design confused the effects of parental speech on child language learning with the effects of changes in the child over these stages on parents' speech and interaction styles.

A subsequent study by Newport, Gleitman and Gleitman (1977) used a follow-up design over a six-month period starting when their 15 child subjects were aged between 12 and 27 months. By partialling out child age and MLU at the outset of the study, Newport et al. made a small step towards controlling for the effects of the child on the mother over this period. However, in interpreting their correlations they made the unlikely assumption that these effects had remained constant over the six-month period; that is, they made provision neither for the possibility of individual differences in rates of development over this period nor for the effects of such differences in bringing about differences in mothers' speech styles during the follow-up period. Their design yielded few clearcut effects of features of maternal speech style on the children's subsequent growth in spontaneous speech measures.

Another method of attempting to control for the effects of child ability on mothers' speech has been used in our research. In a study by Cross (1978), children at Brown's first stages of language development were matched in 10 pairs for precise stage of development using both comprehension and speech measures. Because the children in each pair differed in age by more than seven months on average, it was possible to assign one child in each pair to an Accelerated Child Group (AC) and the other to a more slowly developing Normal Child Group (NC), and then to compare features of their mothers' spontaneous speech to them to determine which aspects of the input were associated with rapid rates of development. Table 1 summarises the relatively few features that were found to differentiate the two groups reliably.

As shown in Table 1, the majority of differences between the AC and NC groups were found for the measures of the degree of semantic relationship between the mother's responses and the content of the child utterances which had immediately preceded the responses. From these results we concluded that there was a consistent association between rapid rates of development and a primary linguistic input which contained large proportions of utterances immediately incorporating the child's topic into the mother's responses, for example, in the form of expansions, semantic extensions and other types of interpretations[2]. We also found that rapid language growth was associated with a significantly higher rate of altered or partial self-repetitions in the mother's speech. On the negative side, we found that slower development was associated with a higher incidence of self-answering, greater amounts of degradation in maternal speech style (i.e., higher rates of unintelligibility and disfluency), and also higher proportions of maternal utterances in each turn.

Our decision to measure both child and mother's language concurrently in this study had the virtue of limiting the extent to which the children's differential rates of growth could be held responsible for variation in their mother's interaction styles, since, unlike Brown et al. and Newport et al., we did not measure the children's rates of language growth over developmental time. However, as was pointed out in the report of this study (Cross, 1978), there were limitations on the conclusion that could be drawn. Although it was reasonable to conclude that the differences found between maternal styles were associated with rapidity in language development, precisely which specific features were causally related in a direct way and which were related only in "syndrome" fashion to the mother's total approach to the child could not be disentangled.

A second limitation resulted from having a range of child abilities which spanned nearly three of Brown's (1973) first stages (i.e., child MLUs ranged from approximately 1.5 to 3.5). We now believe that many of the discrepancies in naturalistic results can be attributed to differences in the stages of the children sampled. No two studies have yet chosen groups of child subjects that are directly equatable in terms of either stage of language development or range of linguistic abilities; and yet there is reason to believe that many maternal speech features may be stage-contingent in their capacity to directly affect linguistic development (Cross, 1979, in press).

Generalisation from this study was also restricted by the selection of fairly homogeneous middle class samples and by the relatively small difference between the child groups in rates of development, since the AC and NC children differed only by an average of seven months (ranging from 4 to 10 months across pairs).

Only two other published studies have used naturalistic methods. Furrow, Nelson and Benedict (1979) selected seven children at 18 months with MLUs below 1.4, coded their mother's speech for about 30 features, and correlated these directly with measures of their children's syntactic complexity in spontaneous speech nine months later--i.e., a prospective follow-up design like that used by Newport et al. However, they obtained quite different correlations, concluding that many syntactic aspects of maternal speech (over half their measures) were causally related to more complex child speech nine months later.

Ellis and Wells (1980), like Brown et al., adopted a retrospective design using two selected groups of about 20 children from Wells' large longitudinal observations of Bristol children from 15 to 42 months. One group, "fast developers", had been selected because Wells' records showed that they had achieved a growth of two MLU points within six months of the starting point and the other group, "slow developers", had taken more than 12 months to make the same gain. After comparing over 30 mothers' speech features for both groups at the starting point, they reported differences on 10. Their results appeared to represent a mixture of Newport et al.'s and Cross' results, but bore little resemblance to those of Furrow et al. (Wells & Robinson, in press).

The Present Study

The present study was undertaken for two basic reasons; firstly to replicate the findings of Cross' previous comparison of mothers' speech to accelerated and normally-developing children but using differently selected groups for comparison; secondly, to specifically investigate the nature of maternal speech to children who were slow language learners. The investigation was designed to ameliorate the problem posed by the influence of the child's linguistic maturity on maternal speech over development in two ways; firstly, by equating all children as closely as possible for level of linguistic ability, and secondly, by reproducing the simultaneous comparative design of the AC-NC comparison so that the time between the observations of maternal speech and child linguistic ability was not a problem. The comparison in this instance was between the mothers of normally-developing children and language-retarded children, the argument being that, given our inability to draw firm causal conclusions on the basis of the earlier comparison alone, the case for a causal relation between mothers' linguistic input and child language development would be strengthened if a compatible pattern of differences were found to be associated with both acceleration and delay in the language acquisition process.

Thus, 10 pairs of children selected for both comprehension and spontaneous production and then assigned on the basis of age to either a normally-developing group or a delayed-development group; that is, within each pair the younger child was assigned to the Normal (NC) group and the older to the Delayed (DC) group, and the speech and conversation styles of their mothers was compared.

Method

The child subjects for this comparison were a group of 10 specifically languaged-delayed children (5 boys and 5 girls) aged between three years ten months (3:10) and five years one month (5:1), (mean age 4:5), and 10 normally developing children matched by pairs with the DC subjects for linguistic level, sex, family SES and birth order. The normal group were aged between 1:8 and 2:6 (mean age 21 months). The range of linguistic abilities was kept as narrow as possible with MLU ranging only between 1:6 - 2:1 for both groups. The mean age difference, however, was much larger than for the previous comparison, a mean of 27:8 months (ranging from 22-35 months). The delayed children were contacted through speech therapists, speech clinics and the SPEECH organisation in Melbourne; but no mother had been involved in a parent intervention programme. The normal group were contacted through playgroups and preschool centres and were included only where their teachers judged their language development to be quite normal.

Each pair from each group was equated on the following measures of stage of language development: (1) Mean utterance length (Brown, 1973); (2) Mean maximum utterance length (Cross, 1975, 1977, 1978); and (3) Scores on a language comprehension test used in our laboratory and developed for our research (Cross, 1975, 1977, 1978).

Audio-recordings of spontaneous conversations between the children and their mothers were taken in the children's homes while they were occupied in joint play with a standard set of toys. The mothers were not told that either their own or their children's language was the subject of the investigation until after the recording session had been completed. The recordings were of approximately one hour each and were initiated only after the mother and child had been playing for at least 15 minutes and appeared relaxed. The recording sessions were broken up according to the children's interest in the toys, and interspersed with the administration of the comprehension test items which was achieved with the mothers' assistance.

Seven independent analyses of maternal speech and language use were undertaken, using sequential samples of 300 maternal utterances from each transcript: (1) utterance complexity, (2) major sentence types, (3) discourse relations between utterances, (4) speech fluency, (5) referential quality, (6) conversation structure, and (7) tutorial devices.

Each major aspect was subcoded into several subordinate categories of measures for each feature which produced 82 features in total which were then compared for the DC and NC mothers[3]. Since the subjects had been drawn from two extremes of the population of children acquiring language, the non-parametric version of the correlated *t* test, the Wilcoxon Matched Pair Signed Rank Test (Siegel, 1956) was employed to test the reliability of the differences across the pairs, the level being set at .05 (1tt).

Results and Discussion

Table 1
Summary of the Patterns of Differences in the AC-NC1 and DC-NC2 Comparisons

Mothers' Speech Features	AC Means	NC1 Means		DC Means	NC2 Means	
Discourse Features						
Exact imitations	3.71	2.58	*			
Complete expansions	7.46	5.79	*	8.05	9.05	*
Partial expansions				5.50	7.78	*
Elaborated expansions	5.67	3.39	**			
Total interpretations	22.83	18.54	**			
Predictate extension	.91	.25	**			
Interprets + NP extensions	36.17	29.92	**			
Interprets + Tot. extensions	59.37	50.92	**			
Interprets x repetitions	7.96	5.75	*			
Extensions x repetitions	17.00	12.16	**			
Total synergistic sequences	24.96	17.92	**			
Semantic unique responses	3.71	5.42	*			
Theme-related responses	9.04	12.92	*			
Tot. noncontingent responses	12.71	18.37	**			
Exact repetitions				4.55	2.17	**
Partial repetitions	8.25	6.54	**	6.78	8.94	*
Self answers	.71	1.25	**	8.17	2.33	**
Stock expressions				4.11	2.78	**
Syntax						
Questions				49.22	37.39	**
Wh questions				26.17	18.44	**
Imperatives				9.50	5.55	**
Regular imperatives				6.89	4.28	**
Pronouns	.63	.44	*			
Referentially						
Attentionals				4.89	3.50	*
Remote references				22.33	8.00	**

... cont

Table 1 (cont)

Mothers' Speech Features	AC Means	NC1 Means		DC Means	NC2 Means	
Speech Style						
Amount of speech (M/C Utts)				.93	1.12	*
Rate of speech (WPM)				72.96	66.08	*
Disfluent utterances	2.96	4.00	*	5.63	3.00	**
Unintelligible utterances	.87	1.94	**	3.72	1.72	**
Total degraded utterances	5.00	7.25	**	10.00	5.28	**
Run-on sentences				15.39	8.17	*
Conversational Measures						
Mother utterances per turn	1.51	1.78	*	1.26	1.42	**
Null responses				15.61	11.61	**
Token responses				18.17	13.72	**
Non-informative responses				32.05	25.33	**
Simultaneous talk				2.27	4.16	*
Child overtalk				.67	1.94	*
Tutorial Features						
Quiz questions				18.02	15.77	*
"What's that?" questions				9.39	6.94	**
Prods				1.50	.88	*

* $p < .05$ (1tt)

**$p < .01$

Since the main purpose of the present comparison was to investigate the similarities between the pattern for differences for the DC-NC comparison and the earlier AC-NC comparison, Table 1 presents a summary of the features which differed significantly for both comparisons. Overall it can be seen that, as in the earlier AC-NC comparison, relatively few maternal speech measures significantly discriminated the groups. However, in the DC-NC comparison there was a larger number of reliable differences (27 at the .05 level) than was found for the AC-NC comparison (20 differences). This result presumably reflects the much larger differences in rate between the children in the NC and DC groups.

In general, it can be seen that, while some of the major elements of the previous pattern were retained (e.g., differences in the appropriate direction for some expansions, partial self-repetitions, degraded speech and proportion of utterance per turn), some dissimilar patterns of differences emerged. For instance, many more measures of conversational structure reached significance, and some syntactic, referential and tutorial measures differentiated the groups--none of which were apparent in the Accelerated-Normal comparison. Overall, though, the similar patterns for both comparisons suggest several hypotheses about those features that appear to have a robust association with rate of development, in terms of either faster or slower development--at least for children in the first stages of language acquisition.

1. Mother's speech to the children acquiring language at a slower pace in both comparisons contained fewer expansions (hence less semantic contingency on preceding child utterances) than mother's speech to more rapid language learners. This finding is consistent with several recent studies, both naturalistic and experimental, showing superior growth in complexity of child speech when the primary input to young children contains high proportions of utterances which immediately incorporate the child's own topics and referents in adult responses (cf. Nelson, Carskaddon & Bonvillian, 1973; Newport et al., 1977; Cross, 1978; Ellis & Wells, 1980, and Wells & Robinson, in press).

2. Partial self-repetitions were less frequent in the inputs of both slower groups while exact repetitions were more frequent for the DC group, providing confirmation of the hypothesis put forward by Cross (1977) and de Villiers and de Villiers (1979) that in moment-to-moment adjustments mothers may aid the child's ability to process the input language by actively adjusting the length and complexity of their original utterances, and, thus providing more tractable data for acquisition.

3. There was a convincing confirmation of the suggestion made by both Cross (1975, 1978) and Newport et al. (1977) that higher proportions of degraded maternal utterances of all types are negatively related to ease of language-learning in the child. In this regard, there was a clear replication of the results of the AC-NC comparison and of Newport et al.'s study both of which showed that disfluent and unintelligible speech is more common in mothers whose children are learning language more slowly.

4. A further replication of the Accelerated-Normal comparison was the failure to find significant differences in the syntactic quality (i.e., the grammaticality and complexity) of maternal speech to the faster learning groups. This adds weight to claims made by Newport et al. (1977), Cross (1978) and lately by Wells and Robinson that the syntactic implication that is present in adult speech to children by itself, does not play an important role in assisting children to acquire the structure of language.

The finding that there were some persistent similarities between the patterns of differences for both the AC-NC and the DC-NC comparisons provides support for the claim that these particular features may be causally associated with rate of development at the early stages of language acquisition, particularly where these features also coincide with those found to be associated with faster child language growth in the longitudinal studies discussed previously. Such features were the higher proportions of expansions, semantic topic extensions, and other forms of incorporating the child's topics in the parents' subsequent utterance (Brown et al., 1969; Newport et al., 1977; Ellis & Wells,1980); lower proportions of ungrammatical, disfluent and unintelligible speech (Newport et al., 1977) and lower rates of exact self-repetition and imperative forms (Newport et al., 1977; Furrow et al., 1979). However, like both Newport et al. and Ellis and Wells, we were unable to show any relationship between the grammatical complexity or length of maternal utterances and child language learning. In fact, Furrow et al., have been the only group to suggest such a relationship. A very real possibility is that their negative correlation between maternal MLU at the first recording and child speech nine months later may reflect the influence of the children's variation in comprehension abilities on the mother over the nine month interobservation period. Child comprehension was an aspect of child language which was neither measured nor controlled by Furrow et al. despite repeated findings (Cross, 1977; Cross, Nienhuys & Morris, 1980; Ellis & Wells, 1980; Cross, Johnson & Nienhuys, in press) that growth in this component of language development permits the child to influence variation in the grammatical complexity and brevity of maternal utterances. This means that Furrow et al.'s design is unable to counter the interpretation that the direction of cause and effect is from child linguistic ability to mother's speech adjustment rather than the direction they were interested in--from mother's speech style to growth in child language.

However, while the few results that are consistent across the several studies mentioned are certainly adding to our understanding of the factors affecting language development, I wish to concentrate here on those patterns of difference that were discrepant with, firstly, the observations of other authors and, secondly, specifically in the present comparison of maternal speech to accelerated and delayed language learners.

On the first point, it seems reasonable to argue that it is unlikely that all features of parent speech will have uniform effects on child acquisition at all stages of development. Several researchers (e.g., Brown, 1973; Ervin-Tripp, 1977; Cross, 1975, 1979, 1980; Nelson, 1978) have contended that aspects of parental speech will have stage-contingent effects on language development. Each study mentioned above started out either at a different stage of language development or with the child subjects encompassing different ranges of development; and each has selected a different length of time over which to "wait for" the effects of maternal speech. If, as I have argued elsewhere, some features of parental speech are effective at a particular stage of development (and not before or after), while others come into their own at other times, then different results can be expected as a direct consequence of such variation in the stage and span of development represented by the children in different studies.

Returning, however, to the specific discrepancies of the present comparisons in which variation in stage and developmental span was minimised, there seem to be two plausible explanations. First, if one takes the position that maternal speech is causally implicated in rate of language development, then it is possible to hypothesise that the external factors which inhibit or slow down development (i.e., bring about delayed development) are different in some degree from those which speed up the normal process. One could frame this hypothesis to be even more consistent with our results by positing that while certain concentrations of features in the input may be necessary to produce an enhanced rate of normal development, it may require not only larger deficiencies in this set of features (i.e., those that persisted across the comparisons) but, additionally, deficiencies in other aspects of parent-child interaction to actually slow down or to inhibit the process to the extent evident in our child subjects.

However, research we have recently completed with the mothers of the delayed children of this present study has indicated a second possibility; while the consistent features we have observed across the comparisons may indeed influence rate of development--and the compatibility of our results with prospective-type studies supports this interpretation--the discrepant features may arise because of the child's language delay rather than being directly implicated in causing it.

Work with maternal speech styles to severely hearing-impaired children (Cross et al., 1980, in press) has demonstrated that the experience of trying to interact with a verbally-inhibited partner over several years of development conditions the parents into compensating for the child's linguistic deficits in many ways. The extent and nature of the differences we found between the mothers of hearing and deaf children matched on either age or linguistic ability suggested a further step in our investigation of the linguistic experiences of slow language learners.

Because we are interested in the effect of experience of a language-disorder on mothers' interactions with later normal children, we had included in our original sample of DC mothers, seven who had younger children of almost the same ages and linguistic abilities as our NC child and mother subjects. This permitted us to match each of these DC younger siblings with a child from one of our NC groups and to compare their mothers' speech. It was thus possible to test the hypothesis that it was the special influence of the language-disabled child that caused their mothers to deviate from the NC group by predicting that their speech styles would not differ significantly from the NC group once they were interacting with their matched younger children. The results of this comparison are presented in Table 2.

It can be seen that well over half of the reliable differences between the NC and DC mothers fell below significance when the DC mothers were recorded in interaction with their younger, more normal, children. Many of these differences could have been argued on a priori grounds to represent compensatory devices that the mothers used with their delayed child to impose a conversational style of interaction on a reluctant, communicatively-inhibited conversational partner, e.g., exact self-repetitions, questions (especially quiz questions), prods and attentionals.

The question remains, though, as to what can be said about the differences that were persistent in the DC mothers' differences from the normal group regardless of which child they were addressing. It may be time to frame some specific causal statements. It seems reasonable to claim that those features that have been consistently associated with rate of child language development across all our comparisons, and which also find support in the other studies discussed deserve very close

Table 2
Summary of Differences for the Comparison of Maternal Speech to NC and DC Siblings

Mothers' Speech Features	Delayed Sibling Group Means	Normal Group Means	Significance Levels
Semantically-related Responses			
Partial expansions	5.27	7.27	*
Syntax			
Negative imperatives	.93	.02	**
Speech Styles			
Amount of speech (M/C Utts.)	1.32	1.12	**
Rate of speech (WPM)	87.00	69.60	**
Run-on sentences	12.20	8.33	**
Disfluent utterances	5.67	4.00	*
Unintelligible utterances	4.54	2.60	**
Total degraded utterances	10.07	6.80	**
Conversational Measures			
Mother Utts/Turn	1.41	1.71	**
Null Responses	16.80	13.30	*
Non-informative responses	39.53	27.53	*

* $p < .05$

** $p < .01$

experimental attention as probably robust general influences on rate of development in the early stages; they are the degree of semantic relationship between child's and mother's utterances and the characteristic amount of disfluency and unintelligibility in particular mother's speech. The first is an aspect of discourse style which may make it possible for children to relate meaning and structure because of a close semantic correspondence between their utterances and their mother's; and the second is an aspect of speech style which may serve to reduce confusion in the language the child is attempting to use as primary data.

As for the other features, I would argue that those that co-vary with child rate in some studies but not others should be kept alive as candidates in that role, with the proviso that we investigate further (perhaps at first naturalistically) the likelihood that they may have only limited and specific stage-contingent effects on child growth. But as for those we have found to come and go depending upon the communicative proficiency and interactional behaviour of children (such as those that were no longer apparent in the last comparison, and which we have also noted in comparisons of mothers addressing deaf and hearing children of similar language abilities), these features should become low priority candidates for influencing child language learning. More importantly though, they should serve as a caution in interpreting the increasing body of research showing differences in the primary linguistic experiences of children acquiring language at different rates. The truth may be that the child is reponsible, not only for his/her own pace, but also for the parent's pace, in the language-learning process.

Footnotes

1. The research reported in this paper was funded by a grant from the Australian Research Grants Committee.

2. For a fuller discussion of the pattern of differences found see Cross (1978).

3. It is not possible to present definitions of these features in the space allowed for this paper. However, details of the codes can be obtained by writing to the author; most features are defined in Cross (1977).

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THE DEVELOPMENT OF WORD SEGMENTATION SKILLS IN CHILDREN

William E. Tunmer and Judith A. Bowey
University of Western Australia

It has been argued that the child's fundamental task in learning to read is to discover how to map the printed text onto his existing language (Gough, 1972). According to this view, reading is a derived skill that builds upon language; the reading process is grafted onto the listening process. This would suggest that a minimum degree of awareness of the units of language is required to enable the child to discover the properties of language that are central to the correspondences between its written and spoken forms.

To detect these systematic correspondences, which exist between the subunits of written and spoken *words*, the child must first recognise that one specific written word corresponds to one spoken word. But, as Donaldson (1978) points out, this requires mastery of the logically prior notion that the flow of speech which the child has been producing and interpreting unreflectingly for years is, in fact, composed of words. There is, however, no simple physical basis for isolating words in speech. A spectrographic examination of utterances spoken at a normal rate reveals that words are not separated by pauses or other obvious boundaries; there are usually no "spaces" between successive spoken words, as there are in printed text. In fact, there are often larger spaces within words than between words (Foss & Hakes, 1978). Words, like phonemes, are highly derived, abstract entities resulting from the operation of prior mental processes.

An important question, clearly, is whether young children are aware that utterances consist of words (which is different from simply *using* words to identify objects or produce utterances). Available evidence suggests that they are not. Several investigators have reported that beginning school children are generally unable to segment meaningful sentences into their component words (Ehri, 1975; Hall, 1976; Holden & MacGinitie, 1972; Huttenlocher, 1964; Karpova, 1966; Berthoud-Papandropoulou, 1978; see Bowey & Tunmer, 1980, for a review of available research).

Two general experimental procedures have been used to investigate word segmentation abilities in children. In the first, the child is asked to repeat a sentence and say the first word and then the second, and so on, until the end of the sentence. The difficulty with this approach, however, is that it presupposes an understanding of the metalinguistic term *word*. As the findings of Downing and Oliver (1974) suggest, children up to eight years of age do not have an adequate concept of what constitutes a spoken word. Studies employing this procedure, therefore, have confounded children's knowledge of the term *word* with their ability to segment speech into words. Consequently, they may have underestimated children's awareness of words as linguistic units.

The second experimental procedure requires children to segment meaningful sentences and phrases into words by either tapping for each word spoken or by representing each spoken word with a physical object (e.g., plastic chips, small wooden blocks). Although the term *word* is used in the instructions, practice items are usually given, followed by corrective feedback. Children are then presented with sentences of varying length and syntactic complexity. A potential problem with this procedure is that it requires the child to perform the simultaneous tasks of recalling sentences and identifying their lexical units. The processing demands of the task may be too great, especially when longer sentences are used.

In addition to the overall poor performance of 5- and 6-year-olds, virtually all the studies on word segmentation have found that such children perform better on contentives (e.g., nouns, verbs) than on functors (e.g., articles, prepositions, conjunctions). Apart from this, however, factors that may be affecting children's performance on word segmentation tasks have not been studied systematically.

The single exception to these general findings in the literature is a study by Fox and Routh (1975) which purports to show that 4-year-olds and, to a large extent, even 3-year-olds can segment sentences into words. Children from 3 to 7 years of age were asked to repeat "just a little bit" of a spoken utterance. Following a single example, the children were tested on sentences from two to seven words in length. If they responded with phrases, they were then led to segment each multiple word phrase further, using the same procedure. Fox and Routh found that 4-year-old children could segment seven of eight test sentences, while even the 3-year-olds could segment five. However, these results do not necessarily indicate that children are aware of words as linguistic units distinct from phrases, syllables, or phonemes, since the experimenter continued asking for further segmentation until word units were produced, and then stopped.

In the present study, a series of three experiments was conducted to investigate factors potentially affecting young children's ability to segment speech. Two features of the study distinguish it from most others. Firstly, explicit demonstration and corrective feedback of practice items were incorporated into the pre-test procedure of each experiment to ensure that children's performance on a word tapping task was not confounded with knowledge of the term *word*. Secondly, the length of test items was limited to two and three words.

In each of the three experiments, independent samples of 48 four-, five-, and six-year-old children were tested, eight boys and eight girls at each age level. The children were obtained from seven separate primary and preschools, each of which is located in a predominantly middle class residential neighbourhood in Perth. All of the children tested were native speakers of English.

The same procedure was used throughout the three experiments. Each child was tested individually in a room in the school he or she attended, or in a mobile laboratory that had been brought to the school. A word tapping task was used to study the development of young children's ability to segment word strings, phrases, and sentences into their constituent words. (In an earlier work, Ehri (1975) used both a word tapping task and a task involving the placement of plastic chips, and found no differences in the pattern of results obtained). Children were asked to repeat a string of words spoken at a normal rate (i.e., there were no pauses between the words) and pronounced with normal intonation, and to tap once for every word. Several demonstration trials were provided in which children were shown how to segment several example strings. Practice trials with corrective feedback were also included in the pre-test phase.

Experiment 1

Materials

In Experiment 1, each child was presented with 32 word strings composed of terms that were likely to be treated as nouns in the vocabularies of young children. The strings were therefore more homogeneous with respect to word class than those of earlier studies, which typically used sentences. Nouns were selected for the first study since previous research has indicated that they tend to be identified as words before other types (e.g., Papandropoulou & Sinclair, 1974).

The noun strings differed in terms of string length (two words or three words), syllabic congruence (match or mismatch between the total number of words and total number of syllables in the string), and plurality (presence or absence of plural nouns in the word string). Examples of test items in each of the various categories are presented in Table 1.

Syllabic congruence was varied to determine whether children responded to syllables rather than words. Unlike words and phonemes, which have no physical analogue in the spectrographic representation of utterances, syllables do have a physical correlate in relative amplitude. In pilot work with earlier versions of the task instructions, it was observed that children often resorted to a syllable strategy when they appeared not to understand the task. Plurality was varied to determine whether children's responses were influenced by word reference. In an experiment in which children were asked to count the words in spoken sentences, Berthoud-Papandropoulou (1978) found that young children tended to focus on the scene evoked by sentences, especially the number of tangible elements represented. String length was included as a variable primarily to avoid effects due to response bias.

Table 1
Types of word strings included in
Experiment 1

	String Length	
	Two Words	Three Words
Syllabic congruence		
Plurality	cakes girls	bike seeds toys
Nonplurality	hill book	hand truck game
Syllabic incongruence		
Plurality	turtles cows	beds garden cats
Nonplurality	shell mother	boy rock table

The strings were made up of words familiar to children as determined by a word frequency list based on children's speech (Wepman & Hass, 1969). A further constraint on the words selected was that they could not be homophonous with other words (e.g., *I-eye*). The order of occurrence of bisyllabic and plural words within strings was varied across the word strings containing them. The 32 resulting word strings were arranged in a quasi-random order, and order of presentation was counterbalanced across children at each age level.

Results and Discussion

Each child was assigned scores representing the percentages of correct word tappings for each level of the three within-subject variables. These scores were subjected to a 3 x 2 x 2 x 2, Age x Syllabic Congruence x Plurality x String Length analysis of variance. The only effect to reach significance was the main effect for Age ($F(2,45) = 9.254$, $p < .001$. The mean percentages correct for ages 4 through 6 years were 64.06, 88.87, and 98.83 respectively. The results indicate that, while children's ability to tap noun strings increased with age, their performance was not affected by the number of syllables, the presence of plurals, or the length of the string. A notable finding was that even 4-year-olds performed reasonably well on the task. An examination of the frequency distribution of overall scores for 4-year-olds reveals a tendency toward an all-or-nothing pattern of results. Eight of the 16 four-year-old children scored above 90%, while five scored 20% or lower.

Experiment 2

Materials

Experiment 2 studied children's segmentation of strings constructed from words of varying grammatical class to test the hypothesis that noncontentives such as quantifiers cause more difficulties than contentives. Unlike previous studies, however, words of varying form class were not embedded in sentential contexts. Rather, children were asked to tap two and three word strings, composed entirely of (singular) nouns, verbs, adjectives, or quantifiers (e.g., *some*, *many*, *few*, *both*, *each*, etc.). A total of 24 word strings was presented to each child, six from each of the four word classes (see Table 2).

The words selected were familiar, nonhomophonic, and unambiguous with respect to word class in young children's vocabularies. As noted earlier, children often resort to a syllable strategy when encountering difficulty. Therefore, all word strings were constructed to be syllabically incongruent to avoid the possibility of masking differential effects due to word class. The position of the bisyllabic word within word strings was varied across test items. The 24 word strings were arranged in a quasi-random order, and order of presentation was counterbalanced across children at each age level.

Table 2
Types of word strings included in
Experiment 2

Word Class	String Length	
	Two Words	Three Words
Nouns	bed mountain	rabbit tree shirt
Verbs	listen teach	shoot pretend sit
Adjectives	odd little	sad dirty small
Quantifiers	each many	enough this both

Results and Discussion

The children's scores were subjected to 3 x 4 x 2, Age x Word Class x String Length analysis of variance. The main effect for Age was again significant, *F*(2,45) = 4.276, *p* = .019), indicating that performance on the task improved with increasing age. The mean percentages correct for ages 4 through 6 years were 79.96, 89.90, and 97.16 respectively. The main effect for Word Class was also significant, *F*(3,135) = 10.46, *p* < .001, with means scores of 93.06 for adjectives, 92.01 for nouns, 86.85 for verbs, and 84.09 for quantifiers. Two interactions reached significance, the Age x Word Class interaction *F*(6,135) = 3.441, *p* = .004, and the Word Class x String Length, *F*(3,135) - 6.097, *p* < .001.

An item analysis, however, suggests that these three latter effects, the main effect for Word Class and the two interactions, are due to poor performance on a single word string. The 4- and 5-year-old children found the quantifier string, *all much only*, especially troublesome, perhaps because they confused the first two words of the string, *all* and *much*, with such single words as *almost*, *also*, *always*, *already*, etc. The children who responded incorrectly consistently tapped twice, instead of three times. The pattern of errors for the six quantifier strings is shown in Table 3.

Table 3
Number of children responding incorrectly to
different quantifier strings

Quantifier Strings	Incorrect Responses	Quantifier Strings	Incorrect Responses
all much only	17	every these	6
most nothing some	3	each many	4
enough this both	8	any few	3
		Total	41

More than twice as many errors were made on the *all much only* string than on any of the others. This would at least *partially* explain the main effect for Word Class, since performance on the quantifier strings was the lowest of the four word classes with a mean of 84.09, as compared to the highest for adjectives, with a mean of 93.06. It would also explain the Age x Word Class interaction since the quantifier strings were primarily a problem for the younger children. Of the 17 incorrect responses to the *all much only* string, nine were made by 4-year-olds, seven by 5-year-olds, and *only* one by 6-year-olds. Finally the pattern of errors explains the Word Class x String Length interaction, since the children performed especially poorly on quantifier strings that were three words in length, which, of course, includes the *all much only* string.

Overall, the children did quite well on the task, with even the 4-year-olds correctly segmenting 80% of the strings. Also, the children performed about as well on the quantifiers as on the contentives, discounting the poor performance on the *all much only* string.

Experiment 3

Materials

In Experiment 3, grammaticality was varied to test the hypothesis that children cannot distinguish between the form and content of meaningful utterances when asked to perform a word segmentation task. Virtually all previous studies of word segmentation skills in children used sentences only. Word class was also included as a variable to determine whether the presence of functors (like quantifiers) increases the difficulty of segmenting sentences. Each child was presented with 24 two and three word strings, half of which were grammatical and half ungrammatical. Of these, half contained adjectives and have quantifiers (see Table 4).

As before, familiar words were selected, and the strings were constructed to be syllabically incongruent. To control for possible differential effects between the grammatical and ungrammatical strings due to the specific content of individual strings, the ungrammatical strings

Table 4
Types of word strings included in
Experiment 3

	String Length	
	Two Words	Three Words
Grammatical		
Adjectives	slow turtles	happy girls play
Quantifiers	most babies	many boys swim
Ungrammatical		
Adjectives	turtles slow	girls happy play
Quantifiers	babies most	swim boys many

were formed by scrambling the word order of the grammatical ones. The resulting pairs of grammatical strings and their ungrammatical counterparts were arranged such that for half the pairs, the grammatical string was presented earlier in the list of test items than the ungrammatical string, and vice versa for the remaining half. Order of presentation was counterbalanced across children at each age level.

Results and Discussion

A 3 x 2 x2 x 2, Age x String Type (grammatical vs. ungrammatical) x Word Class x String Length analysis of variance showed that the main effect for Age was again highly significant, $F(2,45) = 7.018$, $p = .003$. The mean percentages correct for the 4-, 5-, and 6-year-olds were 75.81, 88.84, and 98.19 respectively. There was, in addition, a significant Age x String Length interaction, $F(2,45) = 4.841$, $p = 0.012$. The 4-year-olds experienced greater difficulty with the three-word strings than with the two-word strings. However, this effect may be due to response bias exhibited by two of the 4-year-olds. One tapped twice for 22 of the 24 items, while the other tapped twice 20 times. Although these two children were clearly performing poorly on the task, their response bias resulted in artifactually correct responses for most of the two-word strings.

Another interaction to reach significance was the String Type x Word Class interaction, $F(1,45) = 11.849$, $p = .002$. For strings containing adjectives, the children performed better on the ungrammatical strings than on the grammatical ones, while the reverse was true for strings containing quantifiers. Children appear to encounter greater difficulties with quantifiers when they are presented in ungrammatical strings.

Conclusions

Although significant age effects were observed in all three experiments, children performed at a much higher level than was previously reported in the literature. Even the 4-year-olds performed quite well with over half scoring above 90% correct in all three studies. Segmentation performance was relatively unaffected by variables such as string length, grammaticality, syllabic congruence, plurality, and word class.

The high level of performance consistently observed in the three experiments can be attributed to two factors. Firstly, it was ensured that in the training trials the children were given every opportunity to comprehend the task. The use of examples, demonstrated by the experimenter, and repeated by the child, allowed the children to understand the nature of the task even if they did not understand the spoken term word. Previous investigators often only introduced the task verbally. Thus, if the child did not know the exact meaning of the label, word, he could not perform the task.

Secondly, in these experiments, short strings of words, rather than long sentences were used. Previous investigators have almost invariably used longer sentences, and have thus possibly confounded children's memory ability with their ability to segment speech. Although the children could remember the sentences, the strain on memory could well have been sufficient to disrupt tapping performance.

Given that even many 4-year-old children demonstrate segmentation ability, a question that arises is the basis on which such responses are made. Perhaps children are relying on word stress rather than an abstract concept of the word as a linguistic unit. This would explain previous findings that children find unstressed functors in sentences (e.g., *the*, *a*, *and*, *to*) especially difficult to identify in a segmentation task. The words *the* and *a* were not included in the list of quantifiers in Experiment 2 because they are pronounced differently in isolation than in sentences; that is, in isolation they are stressed. In a sentence generation task Ehri (1975) found that when children attempted to put the word *the* in a story, they typically treated it as a person's name (e.g., *The went walking*).

To test the hypothesis that children are able to use stress as a basis for segmenting words, a sample of 24 children was presented with strings comprising two or three pronounceable nonsense words (e.g., *loast namp denster*). By definition children could not be using the notion of "smallest meaningful, permutable unit of language" as the basis for segmentation, since the units were meaningless. Preliminary results suggest that children do, in fact, use stress as a basis for segmenting nonsense strings, tapping once for each stressed syllable. However, the "stress" hypothesis does not account for children's performance on the *all much only* string discussed earlier, since it predicts that children should tap three times, rather than twice, as many children did. The extent to which children use such acoustic factors as word stress in segmenting meaningful utterances remains to be further explored.

Acknowledgements

We would like to thank Robert Grieve, Andrew Nesdale, Chris Pratt, Michael Herriman, and Marion Myhill for their useful suggestions on the conceptualisation and design of the study. Special thanks are due to Robert Grieve for his invaluable comments on this manuscript, and to Andrew Nesdale for his assistance in experimental design.

This work was supported by a grant from the Educational Research and Development Council, and a General Development Grant awarded to the University of Western Australia.

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A QUESTION OF QUESTIONS

Dr. Betty A. Drinkwater
James Cook University of North Queensland

Much of the recent research on children's communication skills has concerned itself with measuring the accuracy of children's decoding of messages and instructions, and the accuracy of their own encoding (Krauss & Glucksberg, 1977; Flavell et al., 1968). In a typical referential communication procedure, two children, each furnished with a matching set of stimulus materials, are seated facing each other but separated visually by a large, opaque screen. The "sender" or encoder, is required to select one of the stimuli--e.g., a block with an abstract design--and describe it so that the other child is able to pick it out from her own set of materials. Glucksberg et al. (1975) point out that the speaker's message must include reference to stimulus dimensions that adequately distinguish the item from incorrect items according to the listener's viewpoint. Not unexpectedly, younger children perform more poorly than do older children on this type of communication task. What is surprising is the apparent extent of this inadequacy. Tests of children in the Princeton school system from the 3rd (approximately 8 years of age) to the 9th grades revealed that 3rd graders did not improve at all over 15 trials, while 5th and 7th graders improved very little. Krauss and Glucksberg (1977), reviewing their research note that in seeking to identify the factors underlying these data they originally concluded "somewhat naively that the primary factor . . . was 'childhood egocentrism'". However, attempts to demonstrate a correlation between standard measures of egocentrism and performance in communication tasks were unsuccessful. The authors point out moreover, that by the age of 8, most children should be beyond egocentrism.

Flavell (1977) has noted that many more naturalistic studies of children's communication skills have demonstrated that children as young as 2-3 years of age can engage in non-egocentric speech and do communicate quite successfully. He arrives at much the same conclusion as do Krauss and Glucksberg (1977). That is, that young children are not lacking in the ability to take the other person's perspective, but rather in skill at recognising the appropriate occasion to do so. Tasks that are overly demanding cognitively (Krauss et al., 1977) or that constitute "cognitive overload" (Flavell, 1977, p. 177), may prevent their communication competence appearing in performance.

> . . . What we are developing so slowly in our studies of children's communication is a constellation of knowledge and skills that reflects the child's interaction with the world and with other people and cultures. The social use of language depends as much on that knowledge as it does on knowledge of language itself. . . .
>
> (Krauss et al., 1977, p. 105)

Among those who have explored the possibility of group differences in interpersonal communication skills is Heider (1971), who found marked social class differences among 10-year-old children in a referential communication task similar to those employed by Glucksberg et al. (1975).

The most obvious of these differences was a stylistic one: length of communication. Middle-class encodings were less efficient than those of lower-class children in the sense that they were approximately three times longer, but only a small percentage better understood. In other respects, including repetition of the information in different styles, and greater use of whole rather than part-descriptive styles, they were more effective than were lower-class encodings. No sex difference or racial differences (between lower-class white and Negro samples) were obtained.

One aspect of communication skills that has received little attention until very recently is the child's skill in requesting additional information when messages are ambiguous or inadequate. How *do* young children react to an ambiguous verbal communication from an adult? Do they use words, or indicate their uncertainty through some non-verbal channel? If they do ask questions, how efficient are their question-asking styles?

Early attempts at examining question-asking styles were based on the "Twenty Questions" parlour game. Mosher and Hornsby (1966) required their subjects to guess the single correct picture from an array of 42 pictures by asking up to 20 questions that could be answered "yes" or "no". Two types of strategy were distinguished: (a) hypothesis-seeking questions (guesses based on no prior information--e.g., Is it the dog?. (b) constraint-seeking questions (those which seek to narrow down the range of alternatives--e.g., Is it a fruit? Does it fly?). Mosher and Hornsby found that (a) declined in frequency between the ages of 6 and 11 years, while (b) increased.

In a recent study employing a referential communication task to examine children's listening and question-asking skills, Cosgrove and Patterson (1977) found that, while 10-year-olds responded to ambiguous messages by requesting further information, younger children 8, 6, and 4 years of age did not spontaneously do so. Only after instructions to ask questions when in doubt did 8-year-olds sharply increase their level of adequate requesting.

Since the task involves a social interaction between children and adults, the possibility arises that there are cultural differences in children's readiness to ask questions of adults, as well as in their question-asking skills. How, for example, would children from cultures which traditionally emphasise non-verbal communication systems respond to an unclear verbal instruction from an adult? Most teachers in formal education systems in the west, for example, assume that the children they teach would ask questions to clarify a message they did not understand. Are children from some racial minorities being disadvantaged by such assumptions? If so, the stage is set for cumulative misunderstandings, with a lowering of the communicative efficacy of the teacher and the learning potential for the child.

Although most educationists in this country would agree that children are more likely to learn when they are encouraged to ask questions freely of their teachers, most of our formal teaching systems are geared to obtain answers rather than questions from students. There is little research evidence as to the readiness of children to ask questions of adults, or of possible social-class or minority group differences in question-asking skills.

Australian Aboriginal children, according to several investigators, tend to employ non-verbal rather than verbal information-seeking strategies when interacting with whites. McElwain and Kearney (1973) note that children have tended to search their faces for clues rather than scanning stimuli or asking questions when they are unsure how to respond in a testing situation.

Hamilton, in her study of childrearing practices in a traditional Arnhemland community, writes:

> . . . A striking feature of Anbara 3- and 4-year-olds is the lack of questions they ask. . . . The Burara language has no single word for 'why' and the question is so seldom asked by anyone, adult or child, that people have to think carefully before finding any expression for it, when specifically asked to do so . . . .
>
> (Hamilton, 1970, p. 86)

Pierre Dasen goes further and claims that:

> . . . verbal exploration seems to be discouraged, and Aboriginal children do not, apparently, go through the period--well known to European parents--of asking 'why'. This is probably due to the cultural norm of accepting the laws of nature, the social customs, and the decisions of elders without question. . . .
>
> (Dasen, 1974, p. 408)

Study 1

One obvious way in which culture could shape children's facility with the verbal mode is through formalised learning settings such as the school. Another is through games and pastimes. Together with a Japanese colleague, Yuriko Oshima, the present author devised a picture communication task (PCT) which could be administered to children from cultures which until relatively recently had no formalised education systems (Polynesian Hawaii and Aboriginal Australia), and children from cultures which have had for centuries institutionalised methods of training at least some sections of their youth (Japan and European Australia). It was decided to examine the relationships between success on this referential communication task, skill on another verbal game, a shortened version of "Twenty Questions" (the Five Question Game - 5QG) and the ability to define and give examples of Riddles (RILSD AND RISLE).

Although the Australian Aboriginal and Polynesian Hawaiian children who took part in the study came from less traditional communities than those described by Hamilton, it was predicted that the long term cultural effects of largely non-verbal learning and teaching systems would affect both the frequency and form of questions asked by these groups.

The non-naturalistic PCT was chosen as the major investigative measure for two reasons: Firstly, a matter of prime concern was children's skill in communication, not in everyday "home" situations, but in quasi-formal situations such as the classroom, where the other party in the communication is an adult, usually a teacher. Secondly, it was hoped that, should deficiencies in communication be identifiable in such interactions, the need to go back to naturalistic situations within the child's own community, in an attempt to find ways of facilitating the transfer of the child's skills to the classroom, might be highlighted.

The Five Questions Game (5QG) was included in the investigation since this game permits the examination of children's strategies of spontaneous question-asking. Again, it was predicted that Aboriginal and Hawaiian children, as a result of cultural predisposition, might use less efficient strategies of question-asking.

Method

Subjects. One hundred children, aged between 8.0 years and 8 years 11 months, took part in the investigation. The smallest group (H) consisted of 18 children of more than 50% Polynesian ancestry who formed the entire group in the selected age-range at the Kamehameha Early Education Centre in Honolulu. The Australian Aboriginal sample (Ab) consisted of 9 girls and 10 boys randomly drawn from the specified age-range in a North Queensland Aboriginal community school. Nineteen European Australian (EA) children, 7 females and 12 males were also chosen at random from the age-range enrolled in a low SES Townsville primary school some 40 miles distant from the Aboriginal community. Children in these three groups all spoke English as a first language, and were tested in English. The fourth group, (J), consisted of 23 children, 11 females and 12 males selected from the age-range in a Tokyo primary school. Japanese was the first language of these children and they were tested in Japanese.

Picture-book Communication Test (PCT)

Test materials are adapted from Dickson's (1975) study of referential communication skills. Speaker (adult) and listener (child) were seated opposite one another at a small table. Between them was a notebook with identical arrays of eight pictures facing each person. On the listener's side there were eight buttons, one beneath each of the pictures. These were wired to eight lights beneath the corresponding pictures on the speaker's side. The listener (child) was asked to press the button under a particular referent (picture). Pictures varied on three major attribute dimensions, each of which had two values, such as big/small for the attribute size; red/blue for the attribute colour,etc. In order to select the correct referent, the child must be given three critical pieces of information. The test examines children's responses when one, two or three of these critical pieces of information is/are lacking. Ability to decode the speaker's instruction is tested where the message contains all three items of information. There are 12 items in all.

Responses to the PCT were coded in eight categories:

NONR 1 Nonresponsiveness: Lack of either verbal or motor (button-pushing response to the item.

GUESS 2 Guessing: Pushing the button before all critical attributes have been specified.

IMPQ 3 Implicit questions: Statements indicating the child's realisation that the message is inadequate, e.g., "This is crazy!" or "They're all the same!"

GENER4 General questions: Example: "Which one?"

SPEC 5 Specific questions: Questions relating directly to the critical attributes. (Adequate Requesting.)

IRREL 6 Irrelevant questions: Questions relating to non-critical attributes, e.g., tiny irregularities in the drawings.

REDUN 7 Redundant questions: Questions soliciting information already given by the speaker.

CORR 8 Adequacy of Decoding: Indicated by the number of correct responses to full information items.

The Five Question Game

Since it was felt that the presence of concrete referents (e.g., pictures) might unduly promote the incidence of hypothesis-seeking questions, these were excluded from the variant of "Twenty Questions" included in the present study. This meant also that subjects cognitive strategies were not constrained by the experimenter's selection of referents. However, the absence of referents increased the difficulty level of the task, for the proposed age-range of subjects, so the number of permitted questions was reduced to five. Four items were included in the game, giving a possible total of 20 questions over all. Moreover in an attempt to promote constraint-seeking hypotheses, children were told not to guess until they had first obtained information about the target.

The number of Constraint-seeking questions (CSQ) and Hypotheses-seeking questions (GUES) was calculated.

Riddles

Children were given a score of 1 if they gave a reasonable definition (coded RILSD) of riddles, and a score of 0 if they could not.

A similar scoring system was adopted for the Riddles example task (coded RILSE).

Discussion

The hypothesis that differences between racial groups in terms of Formal and Informal learning systems in the not too distant past would be matched by differences in children's verbal information-seeking behaviours in the present, was not confirmed. Two reliable differences were that Polynesian Hawaiians and Aboriginal Australians asked fewer Irrelevant or Redundant questions than did European Australian or Japanese. One might interpret this as more efficient information-seeking, but data on guessing in the PCT, and the tendency of these children to use hypothesis-seeking, rather than constraint-seeking requesting styles in the 5QG do not support this conclusion.

There were significant overall differences between the two broad cultural divisions in Guessing and the asking of Specific questions in the PCT, but the significant interaction indicated that this was due to the fact that Aboriginal children asked the least specific questions and made the most button-pushing responses, while Japanese children asked the most Specific questions.

The category of Non-response was coded into the response categories since it was felt that children from the "non-verbal" cultural traditions might react to a situation of uncertainty by failing to respond at all. In fact very few Aboriginal or Polynesian children did react in this way. It was the European Australian children who indicated their uncertainty significantly most frequently by refraining from either verbal or motor (button-pushing) response. One might speculate here about the validity of the stereotype of the laconic Australian, as compared to more vociferous nationals!

The most efficient performers in the referential communication task (PCT) were those who asked the most SPECIFIC questions. A notable result of this study was the superior performance of the Japanese children. It will be recalled that previous studies have suggested that this task might constitute a cognitive overload for some children. One might ask whether Japanese children are better able to deal with this overload than are children from the other racial groups tested in this study.

Before reaching such a conclusion, one would have to determine whether other possible variables affecting performance in this task were sufficiently well controlled across all groups.

One variable which was difficult to control adequately was the socio-economic status (SES) of children who took part in the study. The Hawaiian and European Australian children were from lower class SES families, their parents being labourers, shop assistants, etc. However, the Australian Aboriginal group constitute the lowest SES group in Australia, so children drawn from this group were not strictly comparable in SES to children from the previously mentioned two groups. Moreover, more specific enquiry into the occupation of parents of the Japanese children revealed that these children came from families which would have been categorised as middle class by the present author, being described by her Japanese colleague as "middle to low professional people".

The rival hypothesis that it was not so much race but social class which was responsible for major differences between groups in this study appeared plausible, so it was decided to test a further group of European Australian children, this time drawn from middle SES families.

Study 2

A group of 21 children (12 girls and 9 boys) was selected, on the basis of their parents' occupations, from the appropriate age-range in a state primary school in a middle class Townsville suburb. All children in this group were sons and daughters of professional people.

Table 1 indicates the performance of this middle class group, labelled MEA, as well as that of the children in the four groups of the previous study.

It will be seen that the MEA group are now the most efficient performers on both PCT and 5QG. Since inspection of the data suggested a substantial influence of social class on performance, it was decided to carry out a separate analysis on the three Australian groups.

Table 1

Mean Scores of all Variables

Task		AbA	EA	Hawaiian	Japanese	MEA
PCT	NONR	0.53	1.47	0.11	0.00	0.67
	GUESS	7.74	5.26	4.33	4.74	2.43
	IMPQ	0.84	0.68	0.56	0.00	0.90
	GENER	0.11	1.16	0.39	0.13	1.19
	SPEC	1.32	9.32	9.94	12.91	15.29
	IRREL	0.05	1.68	0.00	0.52	1.24
	REDUN	0.00	0.16	0.28	2.57	0.86
	CORR	2.32	2.95	2.61	2.71	2.90
5QG	CSQ	0.63	12.61	6.00	7.91	15.51
	5GUES	3.53	3.44	2.00	3.71	3.43
RID-DLES	RILSD	0.05	0.95	0.56	0.35	0.95
	RILSE	0.00	0.74	0.61	0.76	0.81

A two-way ANOVA, Sex x SES, was carried out, and revealed no significant main effect attributable to Sex, and no significant interaction between the factors of Sex and SES

Further one-way ANOVAs were then carried out to assess the effects of SES on the variables measured by the experimental tasks. Scheffé tests indicated a number of significant differences between groups. These are given in Table 2.

Table 2

F Ratios and Significant Differences Between Groups

		F(2,55)	Significant Differences between Groups (p 0.05)
PCT	NONR	2.9	p = 0.06 ns
	GUESS	20.5	ABA > LEA > MEA
	IMP	0.09	ns
	GENER	3.0	ns
	SPEC	53.5	ABA < LEA < MEA
	IRREL	4.7	ABA < LEA and MEA
	REDUN	5.3	MEA > ABA and LEA
	CORR	5.4	ABA < LEA and MEA
5QG	CSQ	126.0	ABA < LEA < MEA
	5GUES	0.06	ns
RID-DLES	RILSD		ABA < LEA and MEA
	RILSE		ABA < LEA and MEA

The data from the three Australian groups, who live within 40 miles of one another, and are exposed to very similar educational curricula administered and taught by the same Educational Authority, lends particular credence to the hypothesis that SES factors play an important part in the development of verbal requesting skills. The lowest SES (Aboriginal) group made significantly more guesses without asking for further information, and asked fewer specific questions in the PCT and fewer constraint-seeking questions in the 5QG--that is, they were less efficient question-askers--than were the low SES European-Australian children, who in turn were less efficient than the middle SES European Australian group. It will be recalled that Heider (1971) had concluded that social class rather than race was the important determinant of children's communication skills. The finding of no significant sex differences in requesting skills also lends some support to Heider's conclusion that sex is not a major factor in determining children's communicative skills.

The prediction that familiarity with question-asking games had a positive relationship to skill in verbal information-seeking received some support from the present study. Aboriginal children, who were the least efficient question-askers, were also least familiar with the Riddles game. That this factor has no simple relationship with requesting skills is demonstrated, however, by the fact that, although both lower and middle class European Australian children had equal familiarity with Riddles, the middle class group performed significantly more efficiently in both the PCT and 5QG than did the lower glass group.

Several authors (e.g., Krauss et al., 1977) have commented on the fact that communication skills depend on many factors, including social interaction factors. In Study 2, the Aboriginal group was the only group tested by an adult of another race, albeit of the same race as their teachers. Nevertheless, it is possible that this factor created an inhibiting effect on the children's performance.

It was noted, however, that although the Aboriginal Australian children asked virtually no questions of any kind during the quasi-formal sessions, yet the tester found no dearth of question-asking behaviours from these same children in informal interactions with herself, and with other members of the community, including teachers. This discontinuity between adequate performance in informal situations and inadequate performance in a formal one bears a strong resemblance to that noted by Cole and Scribner (1974, p. 178f) in their descriptions of referential communication tasks (stick-matching) carried out by adult rice farmers in Africa.

In an attempt to unscramble some of the social factors operating in the formal testing situation, Study 3 examined the effect of Race of Tester on Aboriginal children's performance on the PCT.

Study 3

The community which made possible this investigation was the Aurukun Shire of Cape York Peninsula. Aurukun is one of the most traditional of Queensland's Aboriginal communities, and has one of the few schools where a bilingual teaching program is in operation.

The majority of the people speak Wik-Munkan, either as their first language or as the local lingua franca. Children speak it in the playground and around the community, although the major parts of the school program and associated activities are carried out in English.

Two female testers were used in the study. One was a young middle class white postgraduate who had been resident in the community for some months. She had been accepted into the community's kinship system. The other tester was a young black teacher's aide who was a member of the local community, participating in the bilingual program at the school. She had achieved notable success in the teaching program, and proved very capable in the administration of the PCT.

Unfortunately, the number of children of the appropriate age-range is small. Eight boys and six girls, aged between 8 and 9 years, took part in the study. They were allotted at random to each of the two testers. The white tester administered the test in English, while the black tester administered it in Wik-Munkan.

There was no significant difference between groups. Once again, the great majority of the children guessed by pushing the button, without asking for more specific information where necessary. Only one child asked any question on any item.

Moreover, both testers and the present author found these self-same children spontaneously asking questions, in the testing room, as well as in the school and elsewhere in the community, when they really wanted to know something.

Conclusion

Thus, in the present series of studies, it was only middle class children, European Australian and Japanese, who had relatively little difficulty in transferring adequate requesting skills from informal situations (where they themselves initiate the information seeking) to the experimental tasks. None of the other groups was really successful. Children from lower SES families, both Polynesian Hawaiian and European Australian, achieved group means of less than 10 of the required 18 questions necessary for clarifying the ambiguity of the speaker's instructions.

Aboriginal children, from both high-contact and low-contact communities asked fewest questions. There are certainly cultural factors which suggest explanations for this fact. David Biernoff (1975), in commenting upon values of traditional Aboriginal Society which are virtually the opposite of those held by white Australians, notes that knowledge is not freely accessible, but rather restricted and controlled. It is the perogative of age rather than youth. One might speculate that traditional respect for age and knowledge may mean that children are actively discouraged from questioning their elders.

The latter is certainly true of Japanese children (Oshima, 1979), yet the middle class Japanese group in this study apparently accepted the conventions of the PCT game to the extent that there were no significant differences between the extent of their question-asking and that of the middle class European Australians. In fact, they asked significantly more redundant questions than did any of the other groups.

The difficulty in transferring skills and motivation from the real world to the quasi-formal situation, apparently experienced by Australian children from lower SES families, has serious implications when it is considered that the groups which manifest this discontinuity are also the groups with a lower record of achievement in the classrooms where they are required by law to spend the next seven years of their lives.

Clearly there is a need, as Cole and Scribner (1974) have noted, to enquire systematically into the task specific sources of difficulty. Success in defining the parameters of successful transference in this referential communication task may have important implications for remedying other discontinuities between school and home which are thought (see, e.g., Ciborowski, 1976) to underlie much of the under-achievement of particular groups of children.

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VISUAL LANGUAGE TRAINING FOR APHASIC CHILDREN: TRANSFER BETWEEN SPATIAL AND TEMPORAL SEQUENCES

Barrie Dalgleish
University of Queensland

The apparent, if now disputed, success of language training in nonhuman species has given impetus to the development of language training programmes for the handicapped which use visual rather than auditory codes. In the prevailing exploratory climate the aims of visual language training (VLT) have not been fully articulated, but in principle may be specified as of two types. Type A programmes ultimately aim to develop language skills in the auditory-articulatory format of conventional speech. These programmes are constrained by the difficult task of designing visual forms which are near analogues of conventional language in order to facilitate generalisation from the visual to the auditory. Type B programmes aim merely to endow the handicapped child with communicative skills which he has not previously possessed. They do not presume to establish a generally broadcastable system, but are content with the prospect of improved communication within a limited circle of communicants who are to be trained in their use. Type B programmes need not be concerned with what ought to be, but are free to participate in the pragmatic pursuit of what is effective. Whilst the challenge of Type B programmes lies most clearly in tailoring the system to the abilities and established preferences of the child, it would seem prudent for the proponents of both strategies to design the initial stages of their programmes with these factors in mind.

The training of syntax is an important component of several systems which may be construed to encompass Type A goals. Among these are colour coding systems (e.g., Lea, 1971; Conn, 1976) which represent syntax, a property of spoken language primarily utilising temporal order, in left to right spatial sequences. In this they present a contrast to those who have regarded, though not in an absolute sense, temporal sequence as a property of auditory stimulation and spatial sequence as a property of the visual domain (cf. O'Connor & Hermelin, 1978).

Before commitment to the production of visual analogues of auditory forms becomes too extensive, it would seem important to assess the validity of the assumption that learning transfers between spatial and temporal formats. Some of the basic requirements of this assessment are that it should proceed within the visual modality, since vision provides the primary code for these programmes; it should utilise materials incorporating some basic structural properties of conventional language; and it should attempt to clarify the existing preference systems of handicapped groups if these have not been resolved by earlier research.

Sequencing abilities and preferences in handicapped children

A series of studies using stimulus presentations ambiguous with respect to their mode of sequential organisation led O'Connor and Hermelin to propose that handicapped groups differ from normal children and from one another in their preferred mode for modelling sequences. School age children without handicaps demonstrated a consistent tendency to organise stimulus materials on an earliest to latest temporal basis.

Both deaf and autistic children used spatial order. Only the intellectually handicapped failed to demonstrate a group preference, some individuals using spatial and others using temporal orders. Some groups revealed such a pervasive preference that their ability to utilise the alternative mode became an issue. Thus O'Connor and Hermelin (1973) conducted a test of deaf children's ability to remember in temporal sequence, which proved positive. Subsequent experiments showed that the same child, whether handicapped or not, could use both modes, though the designs failed to address the issue of whether both could be retained for a single presentation.

O'Connor and Hermelin's conclusions, however, have not passed unchallenged, nor have their experiments considered all relevant forms of handicap. Beck, Beck and Gironella (1977) reported that both deaf and normal children had no group preference, but showed the individualised preferences which O'Connor and Hermelin had found only in the intellectually handicapped. Berthelsen (1979) working with moderately intellectually handicapped adolescents, confirmed the lack of preference for that group, also noting that a few individuals seemed able to use both modes at once. Omitted from consideration have been aphasic children though earlier psychometric evidence was available and, following the characterisation of aphasia as a deficit of temporal ordering ability, experiments had been conducted using a variety of sequencing formats.

Visual temporal sequences in aphasia

Poppen, Stark, Eisenson, Forrest and Wertheim (1969) required aphasic children to repeat the order of appearance of lights by key pressing. These children made more errors than controls and were more affected by a delay in response. Like the later O'Connor and Hermelin preference studies, conflicting spatial and temporal orders were used. However as the results were scored only in temporal terms it is impossible to suggest whether the aphasics demonstrated an absolute inferiority in temporal sequencing or whether their deficit stemmed from a preference for spatial orders. A later experiment by Tallal and Piercy (1973) included a condition with a constant locus of presentation. Two shades of green were presented in all possible combinations for durations of 75 msecs with interstimulus intervals (ISI) of 30 to 428 msecs. There were no differences between aphasics and controls for any ISI, and though both lengthening the ISI and lengthening the sequence entail delaying the response, nor were there any differences for sequences varying from 2 to 5 colours.

Visual temporal versus visual spatial sequences

Withrow (1964) obtained comparable performances from deaf, aphasic and normal children for spatial presentations, but both handicapped groups were inferior on temporal presentations. Furth and Pufall (1966) compared deaf, aphasic and normal children on a discrimination learning sequencing task. They found no deaf aphasic differences but young deaf and aphasic children were inferior to normals and spatial presentations were less difficult than temporal.

Auditory temporal sequences

The effects of prosodic features on memory for sequences of words was investiaged by Poppen, Stark and May (1967). Although comparisons were made with younger controls, the aphasics were inferior in retaining sequences of spoken words. Lowe and Campbell (1965) used nonverbal stimuli, 15 msec pulses with rise-fall contours. On judgments of whether the stimuli were simultaneous or successive the aphasics did not differ from controls. However a subsequent experiment using high and low tones produced highly significant differences, dispelling the conclusion that the deficit may be restricted to verbal materials.

Auditory temporal versus visual temporal sequences

Furth and Pufall's (1966) paired associates sequencing experiment included an auditory task using white noise. Younger deaf children were superior to their aphasic age counterparts. The normals were superior to the combined handicapped group. Although the auditory temporal task was easier than its visual counterpart for the hearing, no such effect was found for the handicapped.

As in Lowe and Campbell's second experiment, Tallal and Piercy (1973) reported that for patterns of two rise-fall tones aphasic subjects were inferior to normals. There was an interaction between tone duration and ISI. The deficit persisted with tones of 75 or 125 msecs duration for all ISI's up to 150 msecs. For serial learning tasks with constant ISI's of 428 msecs and series of 3, 4, and 5, the aphasics had great difficulty at 75 msecs duration with all series, and even at 250 msecs were inferior on sequences of 3 and 4.

Tallal and Piercy suggested that the conflict between their results and other experiments which were indicative of a general sequencing deficiency could be accounted for by their use of temporal rather than spatial visual formats, and also by the absence of a response delay.

The Experiment

Design. There were four learning conditions, two for initial training within the same sequencing modality (spatial (S) or temporal (T)) and two for transfer. The first condition of the respective initial learning and transfer phases was used to control practice effects. There were two teaching procedures, production (P) and recognition (R) which alternated to produce four groups of learning conditions as shown in Table 1.

Table 1
Experimental Design

		G1	G2	G3	G4
Initial learning	1.	SP	SR	TP	TR
	2.	SR	SP	TR	TP
Transfer	3.	TP	TR	SP	SR
	4.	TR	TP	SR	SP

The groups were matched as nearly as possible on age and sex. Two parallel experiments were conducted on aphasic subjects and on pre-literate normal children of equivalent language age to the aphasics.

Materials. The production materials comprised a set of rectangular blocks coloured red (16), light green (6), dark green (6), olive green (4) and turquoise green (6); orange (6) and grey (4). The recognition materials were sets of black cards mounted with horizontal sequences of coloured rectangles which matched the blocks in shape and colour. These represented all the possible combinations for sequences of 2, 3, and 4 where each point required a choice between a correct and an incorrect colour. The colours encoded the grammatical constituents of seven forms from Stockwell's list of simple sentence structures of English, excluding the hypothetical element (auxiliary) and the optional elements, and selecting only one of two possible positions for the verb particle (red/noun phrase; green/verb; orange/adjective; grey/verb particle). There was also a model train powered from the mains outlet; a metre of track; a tunnel with a central aperture; a vertical panel comprising a stop and go light and a horizontal panel with four lights.

Procedure. The sequence learning tasks were presented as a game in which the children had to prepare a train to go through a tunnel, past the signal lights and into the station yard. If the train had the correct carriages, that is combination of coloured blocks or of rectangles, the go signal would flash and the train could proceed into the station yard. The seven sequences were presented in random order, and had to be learned to a criterion of four successive correct trials each.

In the production tasks correct and incorrect coloured blocks were presented for each point in the sequence. The child's choice was loaded on the train and screened until the sequence was fully constructed. For the recognition conditions sets of cards corresponding to every combination which could be generated under the production condition were displayed, and the child allowed one choice per pack. The aperture in the tunnel was used for temporal displays. The exposure time was 2 seconds per colour with an ISI of 1 second. Spatial displays were presented outside the tunnel, and the aperture was closed while the train passed through. The aggregate exposure time of the colours was equated for spatial and temporal conditions. While the train was still in the tunnel the stop/go signal indicated correctness of the sequence. Feedback was given for incorrect sequences using the second light panel. Each correct colour triggered a light, successively for temporal conditions and simultaneously for spatial conditions.

Subjects. There were 16 subjects from the John Horniman School, Worthing, Sussex, also the source of subjects for Tallal and Piercy (1973). The age range was 6:8 to 9:2, with a mean of 7 years 11 months. Their mean expressive language age as assessed by the Reynell Scale was 3 years 10 months, lower than their comprehension age of 5 years 1 month. The average language age was 4 years 6 months. The children were from rural centres in south and south east England.

The normal subjects were 36 kindergarten children from a town with a rural and commuter population beyond the outskirts of Brisbane. Their mean age was 4:9 with a range from 4:1 to 5:3.

Results

Repetition of the training procedures reduced the trials required to meet the criterion in all groups. No strong trends were evident for the aphasic subjects to find the spatial mode easier than the temporal though, as the means presented in Table 2 indicate, the production procedure tended to facilitate learning for the spatial group during the initial stages.

Table 2
Means to first criterion trial (aphasics)

	Order of Learning			
	G1 SP, SR: TP, TR.	G2 SR, SP: TR, TP.	G3 TP, TR: SP, SR.	G4 TR, TP: SR, SP.
1.	14.25	19.75	17.50	18.25
2.	18.25	15.50	17.00	15.25
3.	12.50	10.25	12.00	14.25
4.	11.75	11.75	11.25	9.00

An analysis of variance confirmed that there were no group differences, F(df 3) = 0.006. The effect of repeated learning conditions was significant F(df 3) = 6.23, $p < .01$, as was the interaction $F(3,3) = 13.88$, $p < .001$.

Accordingly the means were examined for transfer, first using comparisons of the means for condition 2 of Group 1 and condition 3 of Group 2 and of condition 2 of Group 3 and condition 3 of Group 2, together with the corresponding comparisons for Groups 3 and 4. The percentage savings and t values of the mean differences are presented in Table 3. Savings were evident in all cases, and the associated t values were all significant at beyond the .01 level.

Table 3
Percentage savings indices of transfer and
t values (aphasics)

	SR-TR	SP-TP	TR-SR	TP-SP
% savings between groups	32.87	19.35	16.18	21.31
t	13.48**	5.05**	4.63**	5.47**

** $p < .01$

A second estimate of transfer was computed comparing condition 2 and condition 4 within groups, after adjusting the condition 4 means for intramodal transfer. This procedure has the advantage of allowing a within mode practice condition for the transfer phase. It produced similar savings estimates and again all t values were significant.

The means for the normal group are shown in Table 4. The repetition of training again reduced the trials required by all the groups. The temporal mode did not require more trials than the spatial, though during the initial learning production was again slightly more efficient than recognition under the spatial mode. An analysis of variance showed no significant group effect, $F(3) = 0.20$. Repeated learning conditions approached significance, $F(3) = 2.34$, $p = .07$, while the interaction was highly significant, $F(9) = 46.82$, $p < .001$.

Table 4
Means to first criterion trial (normals)

Order of Learning

	G1 SP, SR; TP, TR.	G2 SR, SP; TR, TP.	G3 TP, TR; SP, SR.	G4 TR, TP; SR, SP
1.	15.50	17.25	18.38	18.25
2.	15.00	12.00	12.63	12.00
3.	10.38	10.50	10.75	10.25
4.	9.37	10.63	9.63	9.63

Transfer estimates and their associated values are presented in Table 5. Again savings were obtained with each procedure, and all *t* values were significant at beyond the .01 level regardless of the method of estimation.

Table 5
Percentage savings indices of transfer
and *t* values (normals)

	SR-TR	SP-TP	TR-SR	TP-SP
% savings between groups	30.00	13.54	20.55	10.42
t	40.74**	14.71**	23.44**	14.14**

Aphasic versus normal performance

An analysis of variance indicated a significant effect for handicap status, $F(1) = 10.80$, $p < .01$. Whilst the initial performance of aphasic and normal children was comparable, the nonhandicapped group benefited more from training. This was not fully evident in the savings estimates because the normals benefited more from intramodality transfer, and so the base for their intermodality estimates was lower.

Discussion

The initial learning of aphasic children matched that of the normal subjects, who were younger, and so by implication may be slower than that of age equivalent normals. Nevertheless they benefited from repetition of the training and all procedures produced significant transfer effects.

These findings support the assumption of Type A VLT's that language training in a spatial sequencing mode can transfer to a temporal situation at least within the visual modality. While the main significance of the experiment for the vindication of current practice lies in this finding, transfer also occurred in the reverse direction. The possibility of using temporal visual formats as an intermediatory phase in the transition from the visual to the auditory should not be overlooked. The convenience of spatial presentations in the remedial situation has become less marked by comparison with temporal presentations with the advent of visual display units which can be utilised for temporal displays of language analogues, whether these be used in a transitional role or merely to add variety to the initial learning procedures.

The results neither support previous findings that spatial sequencing is easier for aphasics than temporal, nor Tallal and Piercy's (1973) suggestion to the contrary. Since Tallal and Piercy did not test a visual spatial group, their contention appears without empirical support. Although the evidence for temporal difficulty lies partly in auditory:visual comparisons, the conflict with Withrow's visual results may be explicable by reference to the structural properties of the sequences taught. The conventional practice has been to generate sequences by random combinations, whereas the materials for the present experiment reflected the commonalities of simple sentence forms. Altom and Weil (1977) have shown that for normal 3- to 5-year-olds the first item of a temporal series of three is the most difficult to retain by comparison with its spatial counterpart, and the middle temporal is slightly more difficult than the spatial midpoint. Although declining, the effect continues through subsequent years. In the present study the effect of temporal decay was counteracted by the acquisition of knowledge of the structure of the sequences, all of which commenced with a noun phrase analogue and were followed by one of the variants of the verb phrase. Thus the children in the initial temporal learning phrases made fewest errors at the earliest positions, not most.

Although spatial and temporal modes have been contrasted here, it should be kept in mind that they may vary simultaneously, as they do in writing and, to a degree, in reading. Simultaneous variations may be important from several points of view. It could be a further format for VLT, and may suggest some hypotheses concerning the mechanisms of transfer. Verbal mediation cannot be discounted, but seems unlikely in the case of aphasics. Spatial sequences may not be independent of temporal order learning, which the subjects can impose themselves through successive inspection patterns. Systematic left to right scanners could acquire a temporal sequence incidental to their spatial learning which would correspond to the temporal sequence of the transfer phase. However there seems to be no comparable opportunity for incidental spatial learning during temporal training, and so an incidental learning account would require the assumption of multiple rather than common transfer mechanisms.

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COMMUNICATING WITH RETARDED CHILDREN: A PRELIMINARY INVESTIGATION

Robert Grieve and Eleanor Allen
University of Western Australia

In recent years considerable attention has been devoted to the many problems involved in making the social and educational benefits enjoyed by nonretarded children available to children who are retarded (e.g., Dunn, 1973; Nirje, 1976). In the present paper we will describe the start we have made on one of these problems, emphasising that what we have to report is no more than a start, for our investigations are still at a preliminary stage.

The problem

The problem we have been studying arises from recent moves to integrate retarded children into normal educational settings--here, the integration of borderline or mildly retarded children (without gross behaviour problems and physically unstigmatised) into normal preschool kindergartens. When this is attempted, two problems immediately arise. First, the retarded child frequently encounters difficulties in communicating effectively. In fact, it has been observed that the communicative competence of the retarded child is frequently lower than would be expected from his general mental age (Smith, 1974; Ingalls, 1978; Neisworth & Smith, 1978), indicating that retarded children typically "underfunction" with regard to communication. The second difficulty follows on from this. Namely the kindergarten teacher into whose kindergarten the retarded child is to be integrated typically lacks experience of retarded children, and she has not been trained to deal with the communication difficulties that frequently arise. The question that we have begun to investigate, therefore, is how kindergarten teachers might be assisted in communicating effectively with borderline or mildly retarded children in order to facilitate their integration into a normal kindergarten setting.

Analysis

The approach we have adopted in trying to answer this question is as follows. First, we have distinguished between what we will call ordinary children (OC) and special children (SC); and between ordinary teachers (OT) and special teachers (ST). The interactions that can occur between such teachers and children are set out in Figure 1.

Figure 1
Interactions between ordinary or special teachers, and ordinary or special children.

Interaction (1) : OT - OC
Interaction (2) : OT - SC
Interaction (3) : ST - OC
Interaction (4) : ST - SC

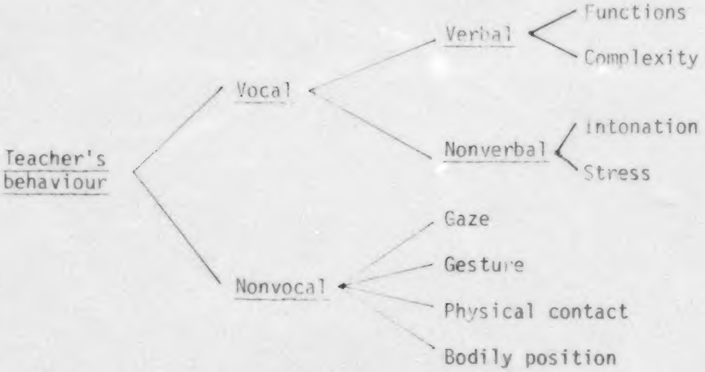
Now when one observes such interactions, even on a casual basis, it seems that what is happening in the various interactions is somehow different--although precisely what the differences are is not always easy to specify at first sight. But roughly speaking, if the interaction is concerned say with the teacher trying to teach the child a new game, then with an ordinary child in Interaction (1), the ordinary teacher provides the child with information, she instructs the child about how to proceed, and she tells the child how he is getting on--, i.e., she provides feedback. With an ordinary child in Interaction (3), the special teacher may well do much the same. However, when the child being taught is retarded, then some sorts of adjustment have to be made, for the special child may well be unable to assimilate the information provided, or decode and follow the instructions the teacher presents. In such circumstances, the ordinary teacher in Interaction (2) may do something which we have observed various inexperienced adults do when faced with retarded children--they seem to concentrate on the quality of their verbal transmission, and try to enhance it. Thus they tend to speak more clearly, speak more slowly, and say things more simply. By comparison, an experienced adult--here, the special teacher--knows that this can be a complete waste of time. This is because she knows that until the interest and attention of the special child are captured and maintained, then trying to communicate with him--no matter how clearly and simply one speaks--is often to no avail. Thus in her interaction with a special child (Interaction 4), the special teacher appears to invest considerable effort in attracting and maintaining the special child's attention and interest in the task. In fact, casual observation suggests that Interaction (4), is quite different from any of the other three types of interaction. It seems much more animated, and the teacher's behaviour--what she says, the way she gestures--may appear to be considerably exaggerated.

These informal observations seemed to us to provide a useful starting point for more detailed investigation. Recall that the ordinary teacher's training and previous experience pertain to communicating with ordinary children as in Interaction (1). The integration problem we are concerned with is exemplified by Interaction (2) --how can the ordinary teacher be helped to communicate effectively with the "communication deficient" special child? Well, first, let us find out just how the ordinary teacher adjusts her communication from Interaction (1) to Interaction (2), without advice. And let us also find out how the special teacher adjusts from communicating with an ordinary child as in Interaction (3), to communicating with a special child as in Interaction (4). What adjustments does the special teacher make towards the special child, in light of her experience of communicating with "communication deficient" special children? If we can identify the adjustments that are made from (1) to (2), if any, and those made from (3) and (4), and then consider what discrepancies exist between these sets of adjustments, an initial indication will be obtained of how to go about advising ordinary teachers on how to communicate effectively with special children. Thus we are essentially trying to capitalise on the experience of the special teacher in communicating with special children, with a view to making this communicative capital available to ordinary teachers.

We have therefore, recently been recording interactions of the types (1) to (4), with a view to identifying what aspects of communication need to be considered. The set of factors we have decided to concentrate on are indicated in Figure 2.

Thus we are considering the teachers' Vocal and Nonvocal behaviour. In Vocal behaviour, Verbal and Nonverbal aspects are distinguished: with Verbal behaviour we intend to study its functions and complexity; and

Figure 2
Aspects of teachers' communicative behaviour



with Nonverbal behaviour we intend to study suprasegmental and prosodic aspects, such as intonation and stress. With Nonvocal behaviour we intend to examine such factors as gaze, gesture, physical contact, and bodily position. It should of course be appreciated that such factors are rarely independent--in the flow of communication they typically interact, and it will be important to consider interactions between factors as our studies proceed. It should also be noted that the teachers' communicative behaviour does not occur in isolation, for in interactive situations, what the teacher does is obviously dependent on how the child proceeds.

What we would now like to do is describe some of the results of a preliminary investigation, in which we have made detailed observations of one adult-child pair in each of the Interactions (1) through (4) of Figure 1. Here we will describe the adjustments teachers make to the communicative functions of their verbal utterances.

Preliminary investigation

The two ordinary children studied were normal, alert, and fairly talkative, one being aged 3.10 and the other 4.8. The two special children were mildly retarded children, C.A.s being 4.3 and 6.0 and M.As, 3.8 and 4.6 respectively. The special children were both quite untalkative, generally, and during our recording sessions. The teachers involved had received training in teaching kindergarten-aged children. The difference between them was that the ordinary teacher had at least two years' post-training experience, on a full time basis, of ordinary children, but no experience of special children, while the special teacher had at least two years' experience, again on a full time basis, of special children. All the children were male, and both teachers were female.

The interactions, which were audio and video recorded using a play-bench apparatus (Grieve & Hoogenraad, 1976), were concerned with playing a specially devised card game, played on a board, which neither the teachers nor the children had seen before. The game was explained to the teachers beforehand, with an indication that it was possible to play it at varying levels of complexity. The teachers were told that we were interested in seeing the extent to which the child could master the game, and each teacher, who was alone with the child in the recording room, was informed that she was free to teach the game as she normally would in a kindergarten. The teachers were allowed to spend as long or as short a time over it as they thought fit.

Before proceeding to consider the communicative functions of the teachers' utterances, some broad characteristics of the sessions, and of the utterances of the teachers, are presented in Table 1 which shows the lengths of the sessions (recall that session length was at the discretion of the teacher); the total number of utterances produced by the teachers in the sessions; and the average number of utterances the teachers produced per minute of session length.

Table 1
Details of sessions, and teachers' utterances

Interaction	Duration (min)	Total utterances	Utterances/minute
(1) OT - OC	18.37	332	18
(2) OT - SC	16.01	282	18
(3) ST - OC	15.05	360	24
(4) ST - SC	9.31	277	29

Here it can be seen that the ordinary teacher spends about 18 minutes on the task with the ordinary child in Interaction (1). She produces a total of 332 utterances, at an average of 18 utterances/minute. With the special child in Interaction (2), she reduces the length of the session by a couple of minutes. Here she produces a total of 282 utterances, again at an average of 18 utterances/minute. The special teacher spends 15 minutes on the task with the ordinary child in Interaction (3) and produces 360 utterances with an average of 24/minute. But with the special child in Interaction (4), she only spends about nine minutes on the task, and produces utterances at an average of 29 utterances/minute. Thus with respect to the time spent on the task, the ordinary teacher reduces this slightly (about 2½ minutes), while the special teacher reduces to a much greater extent (about 6 minutes). With respect to the average number of utterances per minute, the ordinary teacher maintains this constant between the ordinary and special child, whereas the special teacher shows an increase when with the special child.

Now consider the communicative functions of the teachers' utterances, and how these are adjusted for special children. In setting up our categories of analysis, we have endeavoured to strike a balance between the too vague, and the too detailed. We have therefore tried to make our categories precise enough to reveal adjustments, and broad enough so that they will be readily communicable to kindergarten teachers.

Here we have proceeded by considering in more detail the features noted earlier about what can occur in any interaction between an adult teaching a child a new game. It seems that there are three things which can be done, in both general and specific ways. First, specific to the game, the adult can impart information to the child; she can attempt to control how the child proceeds by issuing instructions; and she can inform the child as to his progress by providing feedback. Second, more generally, adult and child can exchange general information (e.g., generally converse); the adult can attempt to generally control the interaction by attracting and maintaining the child's attention; and again, she can provide feedback but now in a general way, informing him about how the interaction is proceeding.

Thus we are considering the teachers' provision of information, feedback, and control, as related to her specific management of teaching the task and as related to her general management of the interaction.

Table 2 shows the proportions of the teachers' utterances which were (a) devoted to the functions of providing information, feedback and control, specifically with regard to the task; and (b) devoted to the functions of exchanging information and providing feedback and control in the general management of the interaction.

These results indicate the following. First, consider the adjustments which are made with regard to specific management of the task. Information. The ordinary teacher considerably increases (16%) the number of information-giving utterances she presents to the special child. The special teacher also does this, but not nearly to the same extent (4%). Control. Both teachers reduce the number of instructions they give to special children, but the ordinary teacher does not do this (13%) to the extent that the special teacher does (26%). Feedback. The ordinary teacher reduces feedback to the special child (9%), but the special teacher maintains constant the amount of feedback she directs to the special child.

With respect to adjustments made to the general management of the interaction, by and large whatever the ordinary teacher does, the special teacher does, but the special teacher adjusts to a much greater extent. Information. With the ordinary teacher, it is noticeable that there is little exchange of general information (e.g., conversation) with either the ordinary or special child. The special teacher tends to generally converse more with both children, there being a slight reduction in the case of the special child (3%). Control. Here, the ordinary teacher slightly increases (3%) the proportion of utterances devoted to generally directing the interaction, but the special teacher does so to a far greater extent (14%). With Feedback, while the ordinary teacher again increases this slightly (3%), the special teacher does so far more (10%).

Thus overall, we can see that with the ordinary child in (1), the ordinary teacher devotes the vast majority of her utterances (83%) to dealing with the task, and far fewer to generally managing the interaction (17%). With the special child in (2) she adjusts this slightly --77% of her utterances are directed to the task, and 23% to generally managing the interaction. With an ordinary child in (3), the special teacher directs 77% of her utterances to the task, and 23% to the general interaction. But when with a special child in (4), her adjustment is far more marked, for now almost as many utterances are directed towards general management of the interaction (44%) as are directed towards the task (56%). Thus when working with special children, while the ordinary teacher adjusts by diverting 6% of her utterances from the

Table 2

Proportions of teachers' utterances deovted to Information, Feedback and Control

Type of Interaction	Management specific to task				General management of interaction			
	Information	Control	Feedback	Total	Information	Control	Feedback	Total
(1) OT-OC	.22	.38	.23	.83	.01	.04	.12	.17
(2) OT-SC	.38	.25	.14	.77	.01	.07	.15	.23
Adjustment	+.16	-.13	-.09	-.06	.00	+.03	+.03	+.06
(3) ST-OC	.14	.41	.22	.77	.11	.09	.03	.23
(4) ST-SC	.18	.15	.23	.56	.08	.23	.13	.44
Adjustment	+.04	-.26	+.01	-.21	-.03	+.14	+.10	+.21

task to general management of the interaction, the special teacher does the same, but to a far greater extent--21% of her utterances are diverted from the specific task to general interaction. We have also seen that the special teacher achieves this diversion by markedly decreasing task-specific instructions (26% in Control), and considerably increasing both general Control (14%) and general Feedback (10%).

The present analysis therefore confirms what we observed earlier. Recall that we said that when one observes interactions of the types (1) - (4), one gains the impression that Interaction (4) is somehow different from the other three. The present results confirm, in a general way, the accuracy of this casual observation, but they go further in that the begin to specify how Interaction (4) is different from the others. Special teachers know that a new skill cannot be imparted to a special child simply by issuing the child with instructions as to how to proceed, for the "communication deficient" special child may well encounter difficulty in decoding and acting upon such instructions. Thus task-specific instructions are greatly reduced. At the same time, there is little point in overwhelming the child with information about the task. Thus although information about the task is increased, the increase is modest, and feedback on the child's progress is maintained. She wants to make sure the special child assimilates whatever information she does present. The special teacher also appreciates that special children need to be worked with in relatively short spells, and thus we observe a considerable reduction in the length of the session. Moreover, in order to convey information to the child, the special teacher appreciates the need to attract and maintain the child's interest and attention, and she does so by diverting a considerable proportion of what she says away from task specifics, and towards more general attention-getting and controlling utterances, and towards more general praise and feedback. To some extent, the ordinary teacher makes some adjustments in these directions, indicating her sensitivity to the differences between the special and ordinary children. But in certain respects her adjustments differ from those of the special teacher; and where her adjustments are similar to those of the special teacher, they are not nearly so marked.

Discussion

At the beginning of the paper, we said that what we would have to report would represent no more than a start on the problem of how adults who are inexperienced in interacting with retarded children might be advised on how to adjust their communication to make it more effective. Clearly, that comment was accurate, for here we have described only one factor from the eight that seem to us to require examination--the adjustments made to the functions of verbal utterances. Further, since our preliminary investigation is confined to but one adult-child pair in the four interaction patterns, we are not at this stage able to gauge the stability or representativeness of our data, nor to consider the problem of individual differences between teachers, children, and teaching styles. So we are not yet ready to try to draw conclusions. But of course, that has not been our purpose, for at this stage it seems to us necessary to provide an analysis of the problem, and articulate a method of tackling that problem. The preliminary investigation described here should therefore be seen as an initial attempt to illustrate how such an articulation might proceed.

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"WHICH OF YOU BY TAKING THOUGHT CAN ADD ONE CUBIT TO HIS STATURE"

Matthew 6: 27

Gavin Seagrim
Australian National University

The idea of this paper came to me during a discussion I was involved in concerning a case in which a skeleton had been cremated. Some doubt was cast on the authenticity of the skeleton because of a disparity between its measured length and the reported height of its supposed previous owner. As we were academics at work, the discussion became animated and involved learned argument about probable errors of measurement. It appeared, however, that there was no question of the authenticity of the cranium. This prompted me to say that, as the cranium--the one-time repository of the deceased person's brain--represented the esssential "him or her", the rest being of trivial representational status, there really was nothing to worry about. My comment was received with shocked silence by my colleagues, who were non-psychologists. Someone muttered that that was the sort of thing you'd expect from a psychologist and the discussion lapsed.

Returned to the security of my study and surrounded once more by colleagues who understood what I was on about, I gave further thought to this question of the essential self and its representation. That it is no longer simply an academic question is made clear by the latest cult in immortality, that of cryonics whose entrepreneurs undertake (if that is the appropriate verb), on contract, to deep-freeze you at death and to unfreeze you in a couple of centuries, by which time it should be possible to correct the faults which led to your demise.

That your identity may then be a serious problem is suggested by their offer of a cut-price contract by which only your head and its enclosed brain would be frozen--they would, on R (resuscitation or resurrection) day, find a torso to fit it on to. Who, then, would you be? Could you sue them for a serious mismatch?

In a more realistic vein, it occurred to me that the question could be debated fruitfully in terms of a comparison between the two God-figures of the psychology of my day--Freud and Piaget. What were their views on the identity of the ego?

While the essential opposition between Freud and Piaget is diametrical on most points, they are in close agreement in the respect which they accord to the rational processes of the mind, processes which they both hold in high esteem.

In Freud's case this is somewhat surprising since rationality is doomed to struggle throughout its secondary existence against superior, primary libidinal forces. It can only hope for success insofar as it is able to subdue or to divert the impulses induced by those forces (a view which led him to dub cognition as "chilled impulse") and, in the process, it, rationality, becomes expedient. An expedient rationality is somewhat of a contradiction.

For Piaget, on the other hand, the body and its experiences, the emotions and volitions, are secondary nuisances which interfere with the clarity of the primary cognitive processes. They cloud the picture, but do not obscure its essential features which are too strong to be erased. And yet the source of rationality is, for him, the activity of that body.

So, for Piaget, the body exists as a necessary, but largely distorting vehicle for the rational mind--mediating reality for it to work on; for Freud the rational mind is the necessary, but often impotent servant of the body--mediating between it and reality.

Both Freud and Piaget were (are) nativists, whatever their protestations to the contrary. Freud's "weird gallery of monsters", as McDougall called them, and Piaget's emerging logical capacities are, for their authors, the prime causal universals of human thought and behaviour. In both cases the development of overt behaviour reflects the interaction of the universals with the constraints imposed by the physical and social worlds. The reflections, however, in both cases are mediated by distorting mirrors.

Freud, of course, held that the causal mechanisms operate at an unconscious level and are inaccessible to direct conscious scrutiny either by the person involved or by an untrained independent observer. An appropriately trained scientist, however, can infer the nature of the mechanisms by applying his inductive capacities to the information provided by carefully controlled observations. But, by definition, the probability of there being residual distortions in the information yielded and in the interpretation of it is high. Thus the observer is forced into rationalisations, into a second order expediency.

Similarly for Piaget. Behaviour itself is an inadequate mirror of the logic which governs it but the existence of logical processes can be revealed by subjecting persons to clever tests and by requiring them to give reasons for their proposed solutions to those problems. But, once again, the inner defences are largely impregnable. While the behaviour may seem rational when interpreted within a particular world view, the subject's production and rationalisation of it depend upon that world view and do not necessarily capture the essence of what is going on in his or her head. And, by the same token, the observer's interpretations of the subject's behaviour are rationalisations based on that same world view and may equally fail to capture the essence of what is happening in the subject's head.

In spite of this, for both Freud and Piaget, if not the high road then the byway to the unconscious processes they seek to understand is via their own consciousness: by fiat, they absolve themselves from the limitations suffered by their subjects. As they themselves are often rational, they both encourage us to believe that the processes of rational thought are ultimately capable of reaching consciousness. For Piaget, and no doubt for Freud, this will come about in the fullness of time (e.g., age) while for both it requires a measure of control, by the wit of the observer for Piaget, by the temporary isolation of the activity from the assimilative clutches of libidinal forces for Freud. At the level of the well trained adult, both therefore consider that rational thought takes place largely at a conscious level. For Freud, as the toiling ego; for Piaget as the decentred knower. Neither of my heroes would locate their own essential identities other than in their brains, as was no doubt the case with Einstein who bequeathed his to science.

Leaving aside whether or not we "believe" that they (as interpreted by me) are correct, we must surely question the rationality of their case which is based on the accessibility to consciousness of the rational processes of the mind, their minds in this case.

I am going to propose a strong negation to this cognitive position. My negation of the cognitive position that I have attributed to my two heroes is aimed principally at the implications contained in it that in some way one's own rationality can, on the one hand, be the source of his own greater rationality and, on the other, that one's rationality can be used to increase the rationality of others.

The negation is encapsulated in the title of this paper: I am quite unable to attribute credit for whatever logical powers I have, or the uses to which I put them, to any individual, myself included.

That this view is not widely shared is attested to by the belief, for which we cognitive theorists are largely responsible, that one *can* become more or less rational (the more the better) by paying attention to one's rationality and by exercising a degree of discipline, of voluntary control over one's mental behaviour, by putting one's mind to it, as my Headmaster used to say. It is partly, if not largely due to this belief that a large proportion of pre-adult humanity is subjected to years of schooling. Indeed, leaving aside contributory social reasons for sending children to school, if this belief were shown to be invalid then our system of schooling would collapse or be radically altered because it is based on the supposition that minds can intentionally be altered in *valued* directions, principally by being made more efficiently logical: one gains a lot of kudos in important quarters in our culture from having a "good logical mind".

As an aside, and deferring the question of the validity of the belief, it is interesting that the desirability of the altered state is never questioned. Like most people who believe themselves to be rational, our rulers in these matters (philosophers, cognitive psychologists, educators and politicians) themselves seldom examine the evidence in a rigorously rational manner but, like Smedslund's (1963) nurses and our first year students (and some later ones), consider only positive instances. A closer scrutiny would surely show that most of the human inspired ills and disasters from which the world has suffered are attributable to the cleverest, the most ruthlessly logical minds. Yet, largely at the suggestion of meek and benign academics, we continue to "buy" the notion that increased rationality is a good thing! Mighty indeed is our faith.

Returning now to my main theme, I had better try to justify my claims.

There are two ways in which we might try to "improve" our own minds or the minds of those who are placed in our charge. The first is by teaching them (and ourselves, understood) the actual operations of logical thinking, the tricks of the trade. The second is by encouraging them to apply those operations, using the tricks. In both cases it is my opinion that the endeavour is futile, or unnecessary, but for different reasons in each case.

The tricks of the trade

Learning the tricks of the logical trade also has two aspects: you might acquire the elements and you might learn how to put them together so that they become maximally efficient in use.

I would have thought that it was quite clear by now that we do not acquire the elements by any obvious learning process. Comparative and developmental evidence is very strongly in support of this on so many fronts that I have difficulty in choosing between them. Köhler showed that chickens apprehended relations of brightness and operated on them, Revesz that they were subject to visual illusions (see Ellis, 1938, p. 203; Katz, 1953, p. 58 & 29 respectively); Harlow (1949) showed that monkeys abstracted "oddity" from a series of experiences; Köhler (1957) showed that apes exhibited insightful solutions to problems by a spontaneous combination of previously uncombined acts; and Piaget showed that children achieve conservation without being taught to. And as both Schiller (1952) with Chimpanzees and countless others with children have shown, there is no propensity below a certain age to benefit from experience or training in these regards. (The widespread concern with the possibility of their being coerced to do so is dubbed the "American question" by Piaget). In other words, training only has an effect on putting to use what has already developed in the animal. So the basic tricks of the logical trade are general properties of mind, or of brains if you prefer, and there is some evidence that they are emergent or maturational. I conclude that all intact minds or brains of a certain age possess them.

The next question is of whether and to what extent their owners can be persuaded to use them.

Applying the tricks

There are again, in the best Piagetian mode of dichotomising, two aspects of this question.

The first, already alluded to, asks whether an animal having those tricks can be persuaded to use them. The second, whether he can be persuaded not to do so! The answer to the first, in my opinion, is that given the necessary concern in the animal for the outcome and in proportion to the excellence of the skill of learning possessed by the animal (a skill which varies widely and unalterably between individuals in all species), then certainly the animal will become more and more adept in the use of the tricks: the tricks can be said to become second nature, which is a most apposite description because for them to become so there must be two inherited characteristics; the tricks and learning capacity on the one hand, and, on the other, an imposed one over which the individual also has almost no control--that is, what he finds motivating.

Again, comparative evidence is strongly in support of my position. Köhler's and Harlow's subjects, in varying degrees, all become progressively more inclined to use their latent skills if the pay-off was adequate. More startlingly Premack's colleagues (Woodruff et al., 1978) have shown that a Chimpanzee can conserve quantity (but without verbal justification!) and Koehler (1951) that birds, and Chen (1967) that rats, can perform quite extraordinary Piagetian feats involving aspects of the use of number when it pays to do so.

In none of these cases has the experimenter taught the animal *what* to do, but only to do it. Indeed, the experimenter, and in my opinion, Piaget, does not have the slightest idea what it is that the animal's brain has got to do (this is paralleled by the inability of computer scientists to define the pattern recognition skills that are required for the reading of cursive handwriting). As evidence, even Piaget's acolytes had no idea why training on class inclusion accelerated the conservation of quantity in their subjects.

The second aspect of the question asks the unusual, almost Freudian question, of whether the emergent skills can be inhibited. If so, how; and does the inhibition lead to an atrophy of those latent skills? I want, again, to discuss two forms of inhibition, the first is unintentional in outcome but achieved by consciously chosen means; the second is intentional in outcome but achieved by means which are not consciously chosen.

I will entitle the first class "*Rego, regis, regit*"--which is the present tense of the third conjunction irregular Latin verb "regere, to rule"--because, as the case in point will show, it illustrates how an irregular procedure leads to an unintended outcome!

My primary school headmaster kept me back after the rest of the class had gone to tea. I was bent over the desk and he had my shoe in his hand with the heel of which he beat out (or in) on my posterior the dirge which heads this section. My task was then to repeat it correctly, which I failed to do: "rego, reges, reget"; or occasionally, for variety, "rego, regas, regat". He gave up eventually and led me in to tea and, before a laughing school, gave me a cushion to sit on. A later, more benign headmaster, applauding an incredible feat of athletic prowess which earned me a second place in the B-grade half mile race, took me aside and said that if only I'd put the same effort into my Latin I'd undoubtedly make the grade. A few years later I obtained 6% and 7% respectively in the two Latin papers in the matriculation examination so I presume, and am sure he thought, that I had not taken his advice. Apart from the fact that these events confirm learning theorists' amazing discovery that punishment is a poor reinforcer of positive response, they pose the question, amongst many others, of what happened to any latent talents I might have had for Latin and my capacity for learning. Well, the story has a happy ending for after 14 years in the kinder environment of the army in peace and at war, I took Latin I at university and came top, not second, in the large class of brilliant students who sat for it that year.

But more seriously, to whom does the credit go for my apparently logical mind and for the uses to which I put it? To my school teachers? To my superiors in the army? To my university teachers? Or to me? Surely to none of these, least of all to me for I found it, so to speak, as easy as falling off a log--I enjoyed it as a logical game; it required of me little effort, no discipline, no moral fibre, no conscious analysis.

To conclude this section, let us look more directly and less personally at the second question, that of the intentional but unconscious inhibition of the exercise of latent skills.

I will give this section the heading of "*To conserve or not to conserve*".

As you all know, but cannot remember, you were once non-conservers, but, one and all, came to conserve. On the other hand Aboriginal children, amongst those of other exotic cultures, generally do not conserve, certainly not at the same early age as you did. But equivalent Aboriginal children reared on protracted doses of uninterrupted Western middle class regimes do conserve without being taught to, more or less at the same age as you did. I therefore conclude that whatever logical capacities are required for this achievement (and we still do not know what they are) are latently present in Aboriginal children in the same proportion as they are in Western middle class children. Why don't they emerge? And what happens to them?

I have claimed elsewhere that conservation is an inevitable, unconsciously tutored product of a form of life that is rigidly regulated, in terms of routine, and of a system of values that emphasises personal possessions and, consequently, quantitative concerns. For example, and as a last personal revelation, my grand-daughter's first three-word sentence was "That's mine a-one". Imagine, therefore, an Aboriginal child trying to apply that kind of basic possessiveness and potentially quantitative concern in his or her Aboriginal home environment: he or she would receive, intentionally, very short shrift. But the motivation behind that negative reaction would almost certainly be unconscious: if you asked them about it you would probably receive the reply, in our terms, that "well, one doesn't, does one?" This response does not express a well formulated, conscious and rational disapproval so much as a general feeling of unease, of discomfort. The reinforcement is only very rarely physical punishment but rather an implicit threat of non-acceptance by the group. So the child's naughty thoughts are packed up and put back where they came from, but with no conscious intent to do so. They simply sink back, out of sight.

This extraordinarily effective but intuitive training procedure draws its unconscious motivation, in my opinion, from the utter incompatibility of the consequences of that kind of behaviour, if tolerated, with the Aboriginal cultural ethic. This incompatibility is far greater and the behaviour more threatening than is that posed by the out-opters for our own society.

So, in the Aboriginal child, the capacities are not expressed. Do they atrophy? The accelerating number of adult Aborigines taking their place successfully at the conference tables of Western society, often without the supposed advantages of literacy or numeracy, apparently effortlessly and often with considerable enjoyment, suggests not. For Piaget these Aborigines would be more fulfilled, for Freud probably more inhibited. Certainly, for both, "they" would be the venue of an exciting struggle between their own largely unconscious but inherent capacities and impulses, and the largely unconscious moulding forces of the two societies competing for the allegiance of their minds.

But the unanswered question remains: Are they Aboriginal or white? Can they ever again, of their own volition, be "dinkum" Aborigines, can they ever, try as they may, be fully white? And, in any given case, who is it that we are talking about? Who, indeed, am I?

Footnote

1. It is of some relevance to my case that even the most rational of us is unwilling to apply Lloyd Morgan's canon to *human* performance. When lower species are shown to exhibit forms of behaviour which we are accustomed to credit to our higher intellectual processes, we tend to feel affronted--the animal has, so to speak, been guilty of a *lèse-majesté*. And energetic efforts are made, in the name of Lloyd Morgan, to reduce its performance to a lower status. The controversy over "language" is a noteable case in point.

Postscript

The news of Jean Piaget's death reached me as this paper went to press. I would like to take this opportunity of offering my personal homage to this great thinker who has been an inspiration and friend to me over the past 30 years.

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MET A PROBLEM WITH METACOGNITION

Chris Pratt
University of Western Australia

Recently, there has been an upsurge of interest in the concept *metacognition* and related phenomena concerned with the ability to reflect on one's thought processes. In the literature on child development recent discussions suggest that the development of metacognitive abilities during childhood may have important implications for the child's performance on a range of tasks. In this context, metacognitive abilities are being introduced to explain aspects of development. But although "metacognition" may hold appeal as an explanatory concept, the introduction of it brings a whole set of different problems to the empirical study of child development. In this paper, therefore, I intend to consider the context in which metacognition is being used in the literature; what is known about it; and how metacognitive abilities have been researched.

First let us look at the use of the concept to explain changes in the child's thought processes during development. In her book *Children's Minds* Donaldson (1978) presents the reader with a very attractive explanation of one of the enigmas of child development. The enigma is that young children (children of approximately six years of age or less) have a number of skills which they use in certain situations but not in others. To take one example, the young child appears to have and use the ability to take the perspective of another person in a range of situations. For example, he can hide a doll from a toy policeman when this requires the ability to think of the situation as being viewed from the policeman's perspective (Hughes, 1975, cited in Donaldson, 1978). Hughes presented the child with a model of two intersecting brick walls and a model policeman placed such that his view of the walls differed from that of the child's. The child then had to place the doll in a position where the policeman could not see it. Children of four years of age were found to be able to complete this task successfully. They would place the doll so that it was hidden from the policeman despite the fact that they could see the doll from their own viewing point. In another situation, Liben (1978) found that young children could say what colour a white card looked to someone wearing glasses with tinted lenses. However, when the young child is faced with the Piagetian three mountains task (Piaget & Inhelder, 1956), where again the ability to take the perspective of another is required, then the child fails. The child is shown a model landscape of three mountains and expected to select from a series of photographs the picture which depicts the viewpoint of a doll that is situated in a different position from the child. In this case, the young child tends to select the photograph which shows his *own* view of the model. Hence we have a phenomenon where the young child does use a skill, taking another's perspective, in some contexts but not in others.

This phenomenon is characteristic of early childhood and is found with respect to a variety of other skills including number, classification and invariance skills (Donaldson, 1978; Gelman, 1978). The child apparently has a restricted range of application of his skills. In providing an explanation for this restricted range, Donaldson argues that there is an important distinction between those contexts where the child does use an ability and those where he does not. The former Donaldson refers to as *embedded* situations, the latter, *disembedded*. Or, to decode the jargon, the former are ones which make immediate sense to the child and where thinking may take place in a meaningful context. Thus the child finds the game of hiding a doll from a policeman meaningful, because even although he has not engaged in the activity of hiding from the law himself he probably has played such games as hide and seek. In contrast, disembedded situations involve moving beyond the bounds of human sense and thinking in situations which are separated from immediate meaning. Donaldson argues that the three mountains task is one example of requiring thinking in disembedded situations and that many other standard Piagetian tasks fall into this category as well. The conservation tasks and the class inclusion tasks in their original form are good examples of these (Piaget, 1952; Inhelder & Piaget, 1964).

Donaldson therefore distinguishes between two types of context--embedded and disembedded. The young child fails to deal with tasks in disembedded contexts in an appropriate way but the older (school aged) child is able to meet the challenge presented by these tasks. This leads to the crucial question: What develops during childhood that enables the child to use his skills in disembedded situations? Donaldson suggests that it is the ability to reflect on one's own thoughts, an ability which she believes appears during the early school years and probably at the time when the child is learning to read.

According to Donaldson then, the young child lacks the ability to reflect on his own thought processes, but the older child has this ability and, as a result, can use his skills in a wider range of situations. In suggesting this, Donaldson is clearly developing Vygotsky's ideas concerning the development of skills in the early school years (Vygotsky, 1962) and although this argument is an attractive one it is also one that is difficult to pursue empirically. The problem lies with the interpretation of the phrase *to reflect on one's own thoughts*, and the subsequent investigation of the appearance of this particular ability. And this is where I met a problem with metacognition. For although Donaldson does not refer to the term by name she is clearly referring to the concept.

Furthermore, Brown and DeLoache (1978), whose thinking also reveals Vygotsky's influence, argue along very similar lines to Donaldson and suggest that a range of metacognitive skills develop during childhood. These skills result in greater control over the thought processes. Thus, in attempting to pursue Donaldson's argument, it would seem advisable to consult the literature on metacognition to see if it may provide further insights into our understanding of development during childhood.

Metacognition has been defined by Flavell (1978) as "knowledge and cognition about cognitive phenomena" (p. 213), again a rather general description, similar in its lack of specificity to Donaldson's "reflections on thinking". It is only once the concept is pursued further that it becomes apparent that in the research context metacognition is not some *unitary* concept of knowledge about cognitive phenomena. Although a general description may be provided, it quickly translates into a series of very specific pieces of knowledge about a range of cognitive phenomena. In fact, the use of the term "metacognition" in this context is a generic one which subsumes metalanguage, metamemory, meta-attention, metalearning, moral judgment, social cognition and problem solving (see Flavell, 1978; Tunmer & Bowey, 1980a). That is, metacognition consists of knowledge about memory, about language, about attention, and so on. Further, within each of these areas, there are some very specific pieces of knowledge that may be acquired. And whereas it is not my intention to try to provide an exhaustive list of these, it is worthwhile considering at least some of the types of knowledge that have been considered. I will do this with respect to two areas--metamory and metalanguage.

Metamemory refers to knowledge about anything concerned with information storage and retrieval (Flavell, 1978). This knowledge has been classified in a paper by Flavell and Wellman (1977), where they discuss two categories of knowledge that come under the heading "metamemory". These are sensitivity and variables. Sensitivity is the appreciation that certain tasks call for intentional memory related behaviours. That is, the child must be sensitive to the fact that he is at times expected to remember information and that when this is so, he must treat this information in a different way to other information. The variables category includes all knowledge that may be acquired concerning factors which influence the process of remembering. Sub-classifications include person variables and task variables. Person variables consist of knowledge that individuals may possess about what they are like as storers of information or alternatively knowledge that people possess that assists them in monitoring their own performance. Task variables on the other hand consist of an individual's knowledge concerning the characteristics of the task that will influence the storage and/or retrieval of the information. Thus, to provide but one example, the knowledge that one list will take more effort to remember than another because the first list is longer would be a clear case of metamemoric knowledge falling within the task variable category. It would be possible to continue to provide many other examples of metamemory which are described by Flavell and Wellman and others. The brief resume provided here, however, is sufficient to give some indication of the vast range of specific pieces of knowledge that a child may learn about his memory processes.

Indeed the development of these aspects of knowledge has been the subject of numerous studies. These studies typically involve either interviewing the child about his memory processes, or requiring the child to make, and justify, judgments about memory tasks. In one study by Kreutzer, Leonard and Flavell (1975), an interview technique was used to investigate children's knowledge of memory. In their monograph the authors report the results of interviews with 20 children at each of four grade levels (kindergarten, 1, 3, and 5). Using questioning techniques suitable for young children, they studied children's knowledge of 12 or more different subtopics. These included general memory ability (questions about remembering and forgetting); immediate versus delayed recall (Does it make any difference if you call a phone number immediately after hearing it or if you have a drink first?--if it does make a difference, why?); and retroactive inhibition (Which friend remembers information better--one who has not done anything related to a particular memory task or one who has?). From these and other questions, Kreutzer et al. conclude that there is much that the kindergarten and Grade 1 children already know about memory. However, there is still more to be learned, as they indicate in the following statement, "...the grades K and 1 subjects did seem to know some things about memory, but the grades 3 and 5 subjects seemed to know some things better and a number of other things in addition" (Kreutzer et al., 1975, p. 52). The conclusion that one may draw from this is that the depth of knowledge and the breadth of knowledge both increase, but even kindergarten children have some knowledge of memory processes. Yussen and Bird (1979) in an experimental investigation of the development of metacognitive abilities draw a similar conclusion. Namely that four- year-old children do have some knowledge about memory, but older children have more. Indeed, this finding is supported by a number of studies which are reviewed by Brown (1977) and Flavell (1978). Thus with regard to metamemory, the area is found to consist of a range of very specific pieces of knowledge, some of which the young child may know though perhaps not quite as well as the older child.

The study of metalanguage in children has followed along similar lines. Again the topic is divided up into a range of very specific abilities. Tunmer and Bowey (1980a), for example, describe metalanguage as consisting of knowledge about phonology, about words, about form and about pragmatics. Further, each of these divisions subsumes a range of very specific abilities. To take the word category as an example, studies have investigated the young child's ability to break up a string of speech into words (Fox & Routh, 1975; Tunmner & Bowey, 1980b). Other studies have investigated the child's ability to distinguish words from non-words (Downing & Oliver, 1973/74; Berthoud-Papandropoulou, 1978) and the child's understanding of the relationship between a word and its referent (Vygotsky, 1962; Lundberg, 1978).

In the Tunmer and Bowey (1980b) study, the authors report that even four-year-olds have sufficient knowledge about words to enable them to count the number occurring in word strings. That is, if presented aurally with two or three word strings, four-year-olds are capable of tapping the appropriate number of times, indicating that they are able to segment the strings into the component word units. Bowey & Tunmer (in preparation) have also found that children from four years of age upwards can in certain contexts distinguish between words and non-words, although they apparently fail to do this in other contexts (Downing & Oliver, 1973/74).

It very soon becomes apparent that the study of metalinguistic skills in children is very similar to the study of metamemory. As is the case with metamemory, the topic of metalanguage also divides into a range of very specific pieces of knowledge that individuals may have, in this instance, about the language system. Furthermore it seems that young children do possess some of this knowledge though not as much as older children--a point that is brought out in the comprehensive review of the area provided by Clark (1978).

Thus, during the last decade or so, the topic metacognition has received considerable attention in the research literature under the separate subdivisions of metalanguage, metamemory, meta-attention and so on. But when this literature is examined it is found to deal with detailed knowledge. Indeed, it is difficult to see the way in which these specific "bits of metacognitive knowledge" relate to the more general ability to reflect on one's own thoughts that Donaldson argues is so important to development in childhood. Donaldson is arguing for an ability that she suggests appears after the child has gone to school. But the evidence quoted above indicates that some knowledge of thought processes develops prior to school age. Perhaps then Donaldson is arguing for a more general all-encompassing level of awareness that is only reached after certain, more elementary, knowledge is gained in the course of development. That is, although some metacognitive awareness may develop prior to the child reaching school age, the level of awareness of this knowledge is not sufficient to enable the child to truly reflect on his own thoughts and successfully complete disembedded tasks. In this sense Donaldson would seem to be arguing for a qualitative change in development that ranges over all the specific contexts the child encounters. But this leads one to consider what level or degree of awareness is required and how it manifests itself. At present we simply do not have the techniques available to directly pursue this problem of awareness and it is clear that much more painstaking research is required.

Even if one takes an alternative view and considers that perhaps it is only a specific awareness that develops in the child at this stage, there are still problems. Perhaps the child comes to know that context does not necessarily immediately convey the meaning of the linguistic signal and that on occasions care needs to be exercised in decoding the message conveyed by a speaker. This would seem to be a more specific knowledge than the general reflections on thought processes, but even so, it still requires consideration to be given to awareness. And if metacognition is in itself a part of cognition (see Feibel, 1978, for discussion of this point), then we may expect that, like so many other skills in childhood, metacognitive skills may themselves only be used in certain contexts and not in others. Thus once the metacognitive abilities are tracked down, it may still be necessary to continue on to establish when they are used and how they influence behaviour.

In conclusion therefore, although interest in metacognition and related concepts has provided us with new ways of interpreting changes that occur during childhood, it has also introduced a number of problems. These are concerned with levels of awareness within individuals and the relationships that may obtain between awareness and behaviour. Consequently the type of argument proposed by Donaldson should not be interpreted as providing an easy answer to the problem concerned with the young child's limited range of use of his skills. The concept metacognition may provide an alternative interpretation of certain data, but it also provides a series of difficult problems of its own for researchers in child development.

Note

This paper originates from research into language awareness in children supported by the Education Research and Development Committee and the Tertiary Education Commission, General Development Grant, (University of Western Australia). I would like to thank members of the language awareness project and Alison Garton for the helpful discussions and comments they provided while I was preparing this paper.

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CHILDREN'S DRAWINGS: A TIME-INTEGRATED MODEL?

Penny Jools
Macquarie University

Children's drawings exist in a number of temporal continua. The child first draws as a sequential act involving a progression from eye to hand--this is the first temporal continuum. Children's spontaneous drawings often occur, however, as an historical development from previous drawings. The close resemblance between successive drawings produced by children is obvious to most parents and has been noted by several scholars in the area (Luquet, 1927; Eng, 1931). The first part of this paper will examine the first continuum, i.e., when the child draws an object for the first time. The focus of the second part of the paper is on this second temporal continuum: the child's drawing in the historical context of her own previous drawings.

Drawing an object for the first time

The various theoretical views which relate to how children draw for the first time may be divided broadly into three categories (Fig. 1).

1).

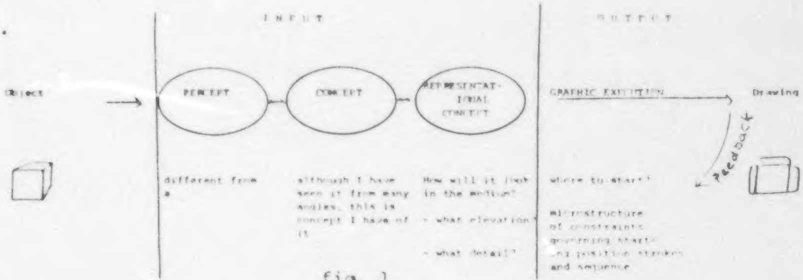

INPUT
OUTPUT
Object
PERCEPT
CONCEPT
REPRESENTATIONAL CONCEPT
GRAPHIC EXECUTION
Drawing
feedback
different from a
although I have seen it from many angles, this is concept I have of it
How will it look in the medium?
- what elevation?
- what detail?
where to start?
microstructure of constraints governing start and position strokes and sequence

fig. 1

First are those which refer to input processes, i.e., that suggest that the child draws from a cognitive or perceptual understanding of the object The second body of research focuses on the output end of children's drawings, i.e., how the forms are compiled in terms of starting position, order of strokes etc. (cf. Goodnow & Levine, 1973; Goodnow, 1977; van Sommers, 1975). Finally, the focus will be on how these processes interact, in other words the feedback from eye to hand in the process of assembling a drawing (cf. Olson, 1970).

Input processes. Input processes in drawing have traditionally been assigned to two theoretical camps (Golomb, 1973) put very simply the perceptionists and the cognitivists. The conflicting view of the perceptionists versus the cognitivists in terms of mental representation has traditionally been stated as the former asserting that the child draws what she sees while the latter contend that the child draws what she knows.

The suggestion made by cognitivists that children *draw what they know* highlights one difference, in my view, between the perceptual and the cognitive writers and this concerns the role of memory or experience in children's drawings. Both Eng (1931) and Luquet (1927) studied drawings executed by one child over a number of years. They were thus primarily concerned with how children draw familiar subjects (which will be dealt with in the second part of this paper). In terms of how experience is related to input processes, however, both Eng and Luquet suggested that the shape the child selects to draw, stems from *prior* visual experience with the object. They argued that the child, after several viewings of an object, will draw it in its "orthoscopic" (Eng, 1931) or "exemplary" (Luquet, 1927) form.

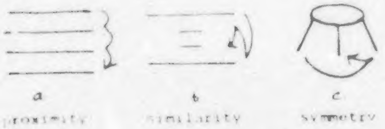
The main contribution from the perceptual camp concerns the role of the medium in children's drawings.

The medium intrudes in internal representation at a number of points in the model I am developing. The medium is clearly most influential at the output stage of graphic production: the child will produce a different representation of the human figure in clay than in pencil. In the case of a child drawing an object for the first time, however, the medium in which she is working will influence the way the object is *inspected*. This is a point made by several writers, in particular Arnheim (1954, 1969), Olson (1970), Golomb (1973) and Gombrich (1969). The latter says,

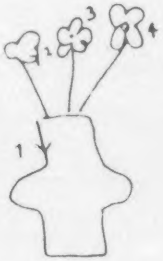
> . . .The features and relationships the pencil picks out will differ from those the brush can indicate. Sitting in front of his motif, pencil in hand, the artist will, therefore, look out for those aspects which can be rendered in lines... he will tend to see his motif in terms of lines, while brush in hand he sees it in terms of masses.
>
> (Gombrich, 1969, p. 56)

Arnheim has developed this idea that different media require a different inspection of the object, to suggest that the draughtsman works with a *different schema or plan* in mind when drawing than the sculptor when planning his work. He calls this general plan, related to the particular requirements of the medium, a *representational concept*. This representational concept is in my view further along a production continuum from perceptual and cognitive processes and is directly related to how a drawing should look in terms of the constraints that the medium poses. (See Fig. 1).

Output processes. Recent work on executive processes, i.e., compilation strategies in children's drawings has focussed on what I term geometric and semantic principles of compilation. The larger empirical work has pointed to regularities that exist in the free placement of lines on a page (van Sommers, 1975), and starting position and direction of strokes in the copying of simple shapes (Goodnow & Levine, 1973). These *geometric* regularities stem from (a) the natural geometry of the body, cf.the "fanning" direction in single stroke making (van Sommers, 1975), and (b) a certain minimal experience with the orthographic tradition, cf. starting simple shapes at the top left (Goodnow & Levine, 1973) or 11 o'clock starting position (van Sommers, 1975). In both of these cases the draughtsman is freed from constraints to do with complex forms. Later work, (van Sommers, 1975) reveals that these regularities break down in more complex drawings under a number of semantic pressures, or constraints which concern the meaning of the drawing and planning for subsequent decisions. Some of which are illustrated below.



(from Van Sommers, 1980)
"normal" top to bottom or left to right regularities are violated in b. for example because like elements are drawn together and in c. for reasons of symmetry.



"anchoring" - pot drawn first

Figure 2:

For younger children the failure to plan for forms in interaction and the compromises which an ad hoc approach to planning in drawing produce, create familiar anomalies, such as the transparency phenomenon. Children who are not yet able to plan the drawing in advance are often constrained by their initial graphic decision. Goodnow (1977) suggests that the frequency of slanted human figures in children's drawings, for example, is the result of an initial drawing of the head on a slant.

What I wish to stress, then, in this section, is the degree to which children's drawing at this output level are a compromise between intention and production. Executive processes exist in a tension between formal geometric constraints to do with the geometry of the body and the nature of the medium, and semantic constraints to do with the meaning of what is drawn and planning for future decisions. To these tensions must be added a final one: checking the drawing against the object or some mental representation of it. What we have here is one aspect of the feedback process, the way in which the input and output processes interact, which is the substance of the next section.

Feedback. Olson (1970) has outlined a detailed account of how process feeds into perception and vice versa. For Olson, the critical factor in production is the information which has to be selected for the particular medium in which the child is working. Perception, argues Olson, is never static in the context of the performatory act, but is highly selective.

Olson is suggesting that in order to draw (as opposed to recognising an object from something else, or working in another medium), the child has to analyse the task not in terms of static features (cf. Maccoby, 1968), but in terms of specifying alternatives.

> . . .If someone is not aware of the alternatives, there is by definition no information. Hence it is innappropriate to speak of all that information being in the stimulus to begin with. . . .
>
> (Ibid, p. 191)

Olson's ideas were developed in the context of his work on children's acquisition of diagonality, but some examples from my own work support the point he is making. The example below illustrates common errors in children's drawings of a five-pointed star (Fig. 3). The predicament the child is in by the time she has reached the end of the "star" began to take shape with the very first stroke. The inner angles of the points are too acute, so that the production resembled a zig-zag. The child lacked an essential ingredient--knowledge of the difference between inner and outer angles.

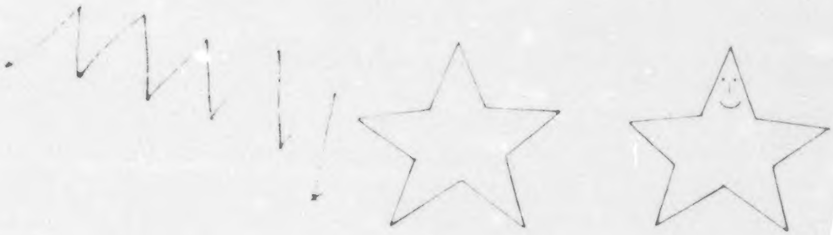


Figure 3:

In a study I did some years ago, I asked children to draw a five-pointed star and an identical star with a face painted on it "Sam Star".

An increase of 13% of 5-year-olds and 20% of 6-year-olds were able successfully to draw the star once they had conceptualised it as a human figure. It would appear that the particular features which the child needed to discern in order successfully to complete the figure were clarified. The angle at (a) has to be opened to make the line (b) assume the horizontal aspect of an arm. In other words, the semantic reinterpretation gave a direction to the strokes, specified alternatives in Olson's terminology, and solved the problem.

Olson is focussing on what is happening at the moment of the first attempt at drawing an object (which is perhaps unfamiliar). It is only during this first attempt that specifying alternatives along a sequence from start to finish is important. Once the stimulus is established as familiar, i.e., once the child is doing a drawing or a variant of it again, the child, I would argue, is concerned much less with the visual analysis of the original object. It is worth noting in this context, the evidence from visual scanning of stimuli, which formed part of Olson's (1970) study. Olson found a difference over time in the visual scan path of children. Once the children knew what to look for their search pattern changed dramatically. One young child, aged four years, having established that the presence or absence of chimneys differentiated the two drawings, searched the pattern only to see if it had a chimney.

Drawing familiar objects

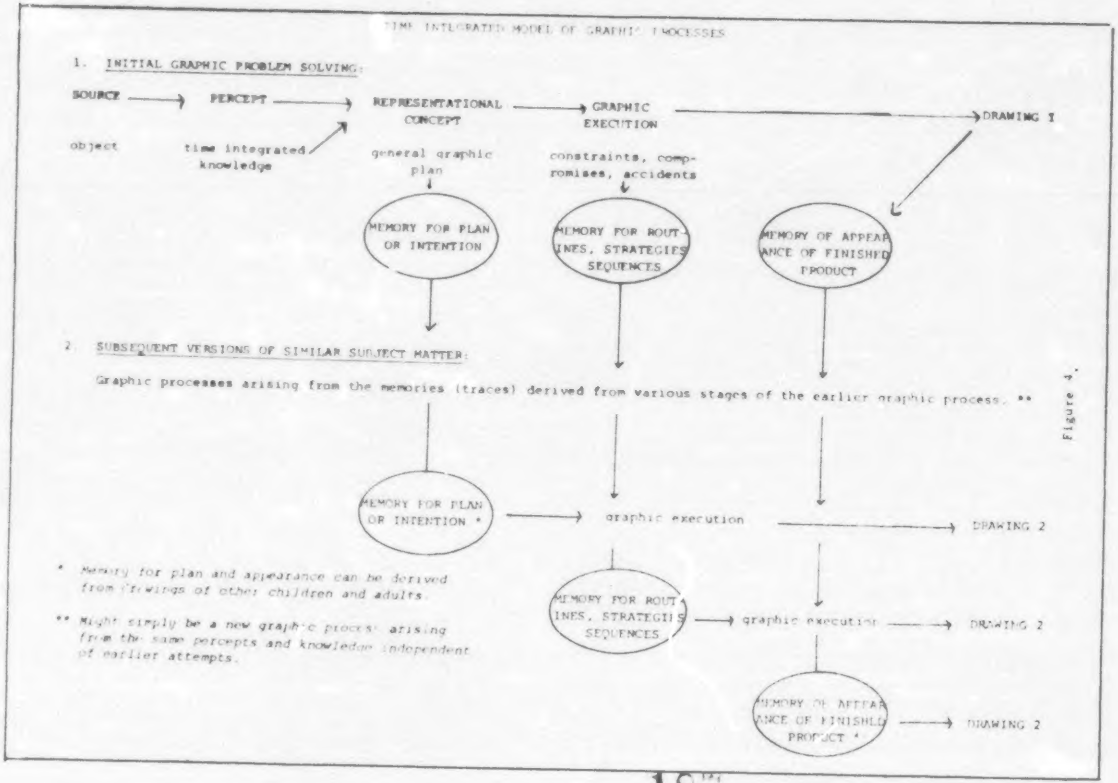
The second part of this paper deals briefly with models for the second historical continuum, when the child draws something she has drawn before. If the child's current drawing is influenced by previous ones, an effect which has been termed "conservation" (Luquet, 1931) or "stereotyping" (Eng, 1931), "conservatism" (Stanton, 1973), then the memory of the previous drawing must affect the way in which the current drawing is tackled. The question of interest here is what form might that model of memory take. There are in my view three candidates for this memory schema each of which is directly related to the first temporal continuum, outlined above. I shall deal with them in reverse order, (Fig. 4).

Memory as a template of the previous drawing. The suggestion here is that the child's first drawing is retained in memory as a template which is reproduced in subsequent drawings. A cursory examination of children's successive drawings over time might suggest that they resemble each other closely. A close analysis of children's drawings over successive weeks (van Sommers, see Fig. 5), suggests that the resemblance is not as close as might at first be thought. Furthermore, work by Robert Stanton at Macquarie University (1973) suggests that conservatism, i.e., a resistance from the child to incorporating information from, for example, a verbal description, occurs even when the child is only asked to think about the drawing, i.e., there is no picture-like image to transmit to memory.

Memory as a motor schema. Both Rouma (1913) and Eng (1931) have suggested that children's drawings of familiar objects become an automatised, routine set of actions. In other words, in terms of the model we have outlined above, it is the executive processes which become the memory schema.

> . . .A series of muscular movements, carried out in a fixed order in the copying of a familiar object or scene, forms a strong and lasting association, to the point that the execution of one of the movements which makes up the sequence, recalls the whole sequence . . . .
>
> (Rouma, 1913, pp. 206-207, my translation)

In my view certain very familiar forms are drawn in a regular routine, the human figure, for example. Sometimes indeed, as several writers have suggested, the force of this routine causes the last item in the sequence, i.e., the arms, to be omitted. I would stress that in my view it is only extremely routine figures which operate in this way.



TIME INTEGRATED MODEL OF GRAPHIC PROCESSES

1. INITIAL GRAPHIC PROBLEM SOLVING:
SOURCE
PERCEPT
REPRESENTATIONAL CONCEPT
GRAPHIC EXECUTION
DRAWING 1
object
time integrated knowledge
general graphic plan
constraints, compromises, accidents
MEMORY FOR PLAN OR INTENTION
MEMORY FOR ROUTINES, STRATEGIES SEQUENCES
MEMORY OF APPEARANCE OF FINISHED PRODUCT
2. SUBSEQUENT VERSIONS OF SIMILAR SUBJECT MATTER:
Graphic processes arising from the memories (traces) derived from various stages of the earlier graphic process. **
MEMORY FOR PLAN OR INTENTION *
graphic execution
DRAWING 2
MEMORY FOR ROUTINES, STRATEGIES SEQUENCES
graphic execution
DRAWING 2
MEMORY OF APPEARANCE OF FINISHED PRODUCT *
DRAWING 2

* Memory for plan and appearance can be derived from drawings of other children and adults.

** Might simply be a new graphic process arising from the same percepts and knowledge independent of earlier attempts.

Figure 4.

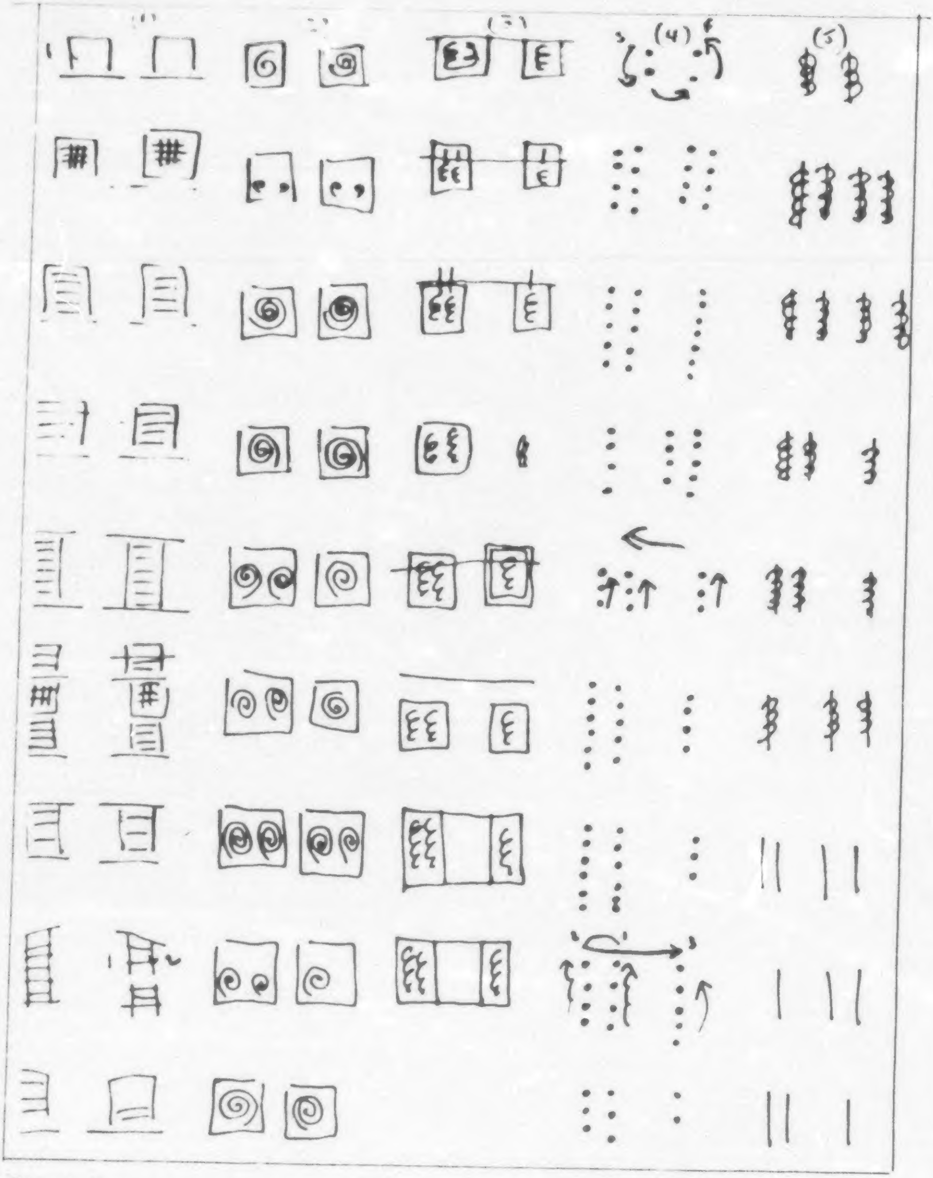


Figure 5

(from Van Sommers 1980)

Point: Children's drawings of a hole-punch over 9-10 successive weeks. Children seem to adhere to much the same schema, although both detail and compilation strategies (see child no. 4) vary.

Evidence against a graphic routine as the only form of memory store arises from the fact that children are so often dissatisfied with their drawings, even when they are of an oft-repeated subject matter. In order to be dissatisfied with the finished product, the child must be checking it against either some more concrete image or a more general abstract schema.

Memory as a general plan or schema. A memory schema at the level of some more general plan relates to the part of our model termed the representational concept. The existence of this form of memory is suggested by: (a) the fact that children are dissatisfied with their drawing but do not know how to alter it, they do not in other words have a template model in their head, (b) Stanton's research, mentioned above, which suggests that an instruction for the child to "think about" how to draw an object will constrain the child from incorporating further information into the drawing, and (c) lastly and most interestingly, van Sommers' work in progress on children's drawings of the same object over successive weeks indicate that while the order in which the parts are drawn varies (which argues against the notion of memory as routine) and the details included in the drawing vary (which argues against the template theory), the general schema remains relatively stable. It is possible for example, as Fig. 5 illustrates, to correctly identify one child's drawing in the sequence as different from another child's. It should be noted however that whatever the schema in memory the child works from, the drawing is still subject to the "accidents" of the graphic execution process.

In summary, I am suggesting that different representational processes operate when children draw something for the first time than when they are drawing something for which a memory trace already exists. In my view historical studies of familiar and unfamiliar objects, along the lines of Peter van Sommers' work, combined with data on the feedback between eye and hand at each stage may clarify how memory schema become substituted over time for active perceptual examination of the object. An integration of historical contexts remains therefore a matter for research.

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ESTIMATION OF LINE LENGTH AND ANGLE SIZE IN SCALENE TRIANGLES BY RETARDED AND NONRETARDED SUBJECTS

P.G. Cole and K.S. Chan
University of Western Australia

Drawings done by children have often been used to make assessments of their perceptual maturity and intellectual functioning. It has often been asserted that such drawings are the product of a system of cognitive processes reflecting organisation and understanding of the external world (Harris, 1963). Piaget and Inhelder (1956) have used children's drawings of geometrical figures as an index of the development of representational space. Representational space is space in which children can imagine or mentally reconstruct an action, and where the schema of these actions has sufficient mobility and flexibility for the internalised actions to become fully reversible mental operations.

Piaget and Inhelder (1956) maintain that it is one thing for a child to perceive an external object and quite another to represent or reconstruct a visual image of it. From as early as two and one-half years of age the normal infant can discriminate between some standard forms, but it is only at a later stage that the child develops concepts of these figures and can reconstruct their visual images (Lovell, 1959). The visual images of such shapes presuppose mental representations, conjured up by the child even though the model objects are not in the perceptual field.

In the very early years the child's representational space is structured with primitive topological relationships (Piaget & Inhelder, 1956). These relationships have dimensions of proximity, separation, order, enclosure and continuity. In time these toplogical operations are enriched by the additon of projective and Euclidean relationships. The construction of projective and Euclidean space requires locating objects or the elements of a single object in relation to each other, within a general perspective or projective system, or according to coordinate axes. Projective or Euclidean structures are more complex in organisation and evolve at a later stage in the child's development.

Piaget and Inhelder (1956) contend that spatial representations are formed through the internalisation of actions performed on objects in space. During infancy these actions are primarily sensorimotor in nature. Through increasingly complex coordination and displacement these overt actions reach a state of internalised actions. Abstraction arises out of appropriate actions, and the coordination of these actions eventually produces meaningful representations. As the abstraction of shape is achieved on the basis of the coordination of actions, it follows that children extract from the object only that which they are able to manifest in action. Indeed, Piaget and Inhelder (1956) indicate that "children are able to recognise, and especially to represent, only those shapes which they can actually reconstruct through their own actions" (p. 43). It follows that such a theoretical viewpoint predicts a strong relationship between the development of representational space and related perceptual-motor responses. The present study attempts to determine the nature of this relationship and tests its validity in an experiment with retarded and nonretarded children.

Research on the development of spatial concepts by retarded children indicates that they progress through the same sequence of stages as that observed in nonretarded children, but that they are less competent in the acquisition of spatial concepts and the representation of spatial relationships than nonretarded children of the same chronological age (Woodward, 1962; Lovell, Healey & Rowland, 1962; Houssiadas & Brown, 1967; Stearns & Borkowski, 1969; Kershner, 1973; Brown, 1973; Rubin & Orr, 1974). However, in none of the above studies was an attempt made to determine which features of the representations discriminated between intellectually average and retarded children. The present study is concerned with the key features in the subjects' drawings that differentiate younger and older children and retarded and intellectually average children. The other important question examined here concerns the relationship between perceptual-motor functioning in nonretarded and retarded children and their ability to represent Euclidean and projective concepts.

Method

Subjects were required to make five copies of a scalene triangle model. To make accurate copies of the triangle required the ability to conceive space in terms of Euclidean properties such as straightness, length of line and size of angle. Such a task reflects the conceptualisation of projective and Euclidean relationships as well as the ordering, organisation and coordination of actions to reconstruct such relationships.

Each subject was also required to perform a joining-points task. In this task the subjects were required to draw lines between several pairs of points marked on standard size paper, using a straight edge. This task provided an index of the child's proficiency in manipulating a straight edge and pencil to draw straight lines between designated points of reference, and as such was a purely perceptual-motor skill.

Subjects. Forty-five borderline and mildly retarded subjects and 45 intellectually average subjects were chosen for the study. Fifteen intellectually average subjects were sampled from each of three different age groups, at eight (mean CA = 8.1 years, SD = 0.32), 10 (mean CA = 10.4 years, SD = 0.46), and 14 years (mean CA = 14.2 years, SD = 0.34). Fifteen retarded subjects were sampled from the same age groups at eight (mean CA = 8.2 years, SD = 0.39, 10 (mean CA = 10.1 years, SD = 0.42), and 14 years (mean CA = 14.3 years, SD = 0.61).

The retarded subjects were randomly drawn from special classes in the public schools and, in rank order from the youngest to oldest group, had mean IQs (Binet or WISC) of 75.3 (SD = 12.54), 72.6 (SD = 8.65), and 73.2 (SD = 7.23) respectively. The nonretarded subjects were drawn randomly from regular classes in the public school system. No IQ data were available for the nonretarded subjects.

Procedure

Subjects were individually tested and given as much time as they needed to complete the exercises. Each subject completed the joining-points task first, then the copying task.

Copying task. A set of five 21 x 30cm stimulus cards of different colours, namely, white, pink, light blue, yellow and green was used for this task. A scalene triangle was drawn in black outline in the centre of each card for the subjects to copy. The triangle measured 12.7cm (horizontal baseline) x 8.9cm (the designated oblique line on the left) and the angle subtended between the horizontal baseline and the designated oblique line was 30 degrees. All the triangles shown on the five stimulus cards were identical and all of the same orientation (the designated angle on the left) and same position on each card.

Subjects drew the triangles on white 21 x 30cm paper, using a straight edge and HB pencil. The five stimulus cards were randomised for all presentations. The cards were placed vertically upright in a wooden holder in front of each subject. The copying task provided measures of the subjects' estimates of line length and angle size.

The first dependent variable was defined as the difference between the size of the model angle and the average of the subjects' drawings of the same angle. As each subject drew five triangles, there were five measures of estimated angle size for each subject. These were averaged to yield one single score, which thus gave a reliable measure of the subjects' estimates of the size of the angle. No distinction was made between over- and under-estimated projections. This score was then subtracted from 30 degrees (the size of the base angle in the model triangle) and the absolute value was taken as the mean error score for the base angle.

The second dependent variable was defined as the difference between the length of the model oblique line and the average of the oblique lines drawn by each child. The third dependent variable was defined as the difference between the length of the model horizontal baseline and the average of the horizontal baselines drawn by each child. In both cases scoring procedures were similar to those used for the first dependent variable.

Joining-points task. There were two 21 x 30cm worksheets for this task. On the first sheet were marked five pairs of points which, when joined made up a vertical (6.1cm), a horizontal (7.7cm), a left oblique (9.0cm subtended at an angle of 125^0 from the horizontal) and two right oblique lines (10.3cm and 5.1cm subtended at angles of 53^0 and 24^0 from the horizontal). The second sheet depicted three sets of points, which when joined formed two scalene triangles (5 x 7 x 8.6cm and 6 x 6.5 x 7.5cm) and one obtuse triangle (4 x 10 x 13cm).

Worksheet 1 was presented first and the subjects were given instructions to join the points accurately with a pencil and a straight edge. Subjects were told to draw the lines in the same sequence: first the vertical, then the horizontal, followed by the left oblique and then the two right obliques. After they had completed this task, the subjects were directed to join the points on the second worksheet in standardised sequence.

Two error scores of the subjects' perceptual-motor ability were derived from the joining-points task, one for each of the two worksheets, the first called joining-points (lines) and the second called joining-points (triangles) scores. These two error scores represented measures of the amount of deviation of the lines drawn by the subjects from the model. The error score was obtained by extending the line drawn by the subjects and the one designated by the points to the edge of the paper and then measuring the distance (in cm) between these points along the perimeter of the paper. Simple geometry (thanks to Euclid) dictates that this error score is an accurate estimate of the subjects' ability to join accurately the designated points. The five measures on the first sheet were summed to give the joining-points (lines) error score and the nine measures on the second sheet summed to give the joining-points (triangles) error score. Subsequently, these two scores were used as predictors in the regression analysis to explore relationships between the subjects' perceptual-motor functioning and their ability to estimate line length and angle size.

Results

A test of homogeneity of variance indicated that it was necessary to transform the copying task scores and the perceptual-motor scores. A square root transformation (Winer, 1962) was found to be appropriate.

Multivariate analysis of variance. The copying task data were analysed first to test for age and ability differences. A multivariate 2 (subject-group) x 3 (Age) analysis of variance was performed on the transformed data. The three dependent variables were the mean error scores for the base angle, oblique line and baseline measures. The means and standard deviations (before transformations) of the three dependent variables are shown in Table 1.

A multivariate analysis revealed a nonsignificant interaction ($F(6,164) = 1.49$, $p < .18$), indicating a constant subject-group effect across the three age levels. There was a significant multivariate main effect for subject-group ($F(3,82) = 3.51$, $p < .02$). Inspection of the data revealed that the triangles drawn by the retarded subjects were less accurate copies of the given model triangle than those drawn by the non-retarded subjects. Results of univariate tests on the three dependent variables examined separately indicated that the significant subject-group effect was confined entirely to the base angle variable ($F(1,84) = 9.68$, $p < .01$).

A multivariate test also indicated a significant age effect ($F(6,164) = 6.13$, $p < .01$). Both contrasts between the 8- and the 10-year-olds and the 10- and 14-year-olds attained significance ($F(3,82) = 8.65$, $p < .01$) and ($F(3,82) = 4.93$, $p < .01$, respectively). The older children were more accurate than the younger ones in their copies of the model triangle. Univariate tests revealed that the base angle variable as well as the oblique line variable showed significant age effects ($F(2,84) = 15.22$, $p < .01$ and $F(2,84) = 9.78$, $p < .01$, respectively).

Multivariate multiple regression analysis. A multivariate multiple regression analysis was completed using the data from both the copying and joining-points tasks to explore relationships among the three predictor variables and the three criterion variables. The two joining-point scores were used to provide a joint measure of perceptual-motor functioning and with the two nominal variables, age and subject-group, made up the three predictor variables. The two perceptual-motor variables were entered first into the equation, then the age and finally the subject-group variables. The three criterion variables were the base angle, oblique line and baseline measur

Table 1
Means and Standard Deviations of the Three Dependent Variables
(Error Scores) for Age x Subject-Group

	Base Angle (in degrees)		Oblique Line (in cm)		Baseline (in cm)	
	M	SD	M	SD	M	SD
8-year-olds						
Retarded	16.97	11.94	2.46	1.73	3.42	3.29
Nonretarded	8.53	6.57	1.44	1.08	1.41	1.46
10-year-olds						
Retarded	9.96	6.83	1.30	1.06	1.68	1.14
Nonretarded	6.27	5.69	1.27	0.63	1.53	1.09
14-year-olds						
Retarded	4.49	2.79	0.86	0.71	1.23	0.91
Nonretarded	2.39	2.28	0.67	0.53	1.47	0.92

Table 2
Multivariate Multiple Regression Analysis - Summary of Results
for Subject-Group, Age and Perceptual-motor Ability
Significance Tests

Source of Variation	Degrees of freedom	Multivariate		Univariate F (percent of variation)		
		A	F	Base Angle	Oblique line	Base line
Perceptual-motor ability	2	0.51	11.47**	30.09** (40.89)	12.82** (22.76)	12.70** (22.60)
Age (eliminating perceptual-motor ability)	1	0.85	5.05**	4.44* (2.90)	3.88 (3.33)	1.48 (1.31)
Subject-group eliminating age and perceptual-motor ability)	1	0.99	0.24	0.00 (0.00)	0.08 (0.07)	0.66 (0.59)
Total percentage of variation				43.79	26.16	24.50

* significance at $p < .05$
** significance at $p < .01$

The multivariate F-test revealed a significant relationship ($F(12,219.89) = 6.99$, $p < 0.01$) between the predictor variables and criterion variables. Table 2 depicts the results of the regression analysis. The contribution of the subject-group variable to multiple criterion variation, after eliminating the effects of age and perceptual-motor ability, was not significant. The multivariate test ($F(3,83) = 0.24$, $p < 0.8$), revealed a nonsignificant relationship. These data indicated that the age group and perceptual-motor functioning measures were sufficient to predict nearly all of the non-error variance in copying ability and that the child's cognitive level (retarded or nonretarded) had no unique relationship with copying ability after partialling out the other variables. The nonsignificant subject-group effect allowed the age variable to be validly tested (Finn, 1974). The multivariate F-statistic was significant ($F(3,84) = 5.05$, $p < .01$) and the univariate results indicated that only the univariate F-test for the base angle criterion variable attained significance ($F(1,86) = 4.44$, $p < .03$). The age variable did have a unique contribution to variation in copying ability (in particular, the variation in accuracy in representing angle size) over and above what could be explained by perceptual-motor functioning.

Discussion

The nonretarded subjects were more accurate in drawing triangles from a given model than the retarded subjects. This, in itself, was not an unexpected finding. The more fundamental research question was concerned with discovering those features of the triangle that most effectively discriminated retarded and nonretarded subjects. The data indicated that when the various elements of the triangle were considered separately, the key difference between the two subject-groups lay in the nonretarded subjects' ability to estimate more correctly the size of the subtended angle and not in their ability to reproduce the base and oblique lines. The angle is the most difficult of the features of the triangle to reproduce accurately, probably because it involves perceptual analysis and synthesis of the segregated elements of the figure (Birch & Lefford, 1967) and the ability to reorganise conceptually the relationships among relevant elements. In order to copy a model of a geometric figure, it is necessary to estimate the dimensions of the several elements separately, perceive the relationships among the elements and the whole and be able to reproduce these several features. Retarded children are clearly inferior in one or more of these critical abilities.

The accuracy with which subjects copied triangles improved across age groups. For both the retarded and nonretarded, the 14-year-olds were more accurate than the 10-year-olds, who were more accurate than the 8-year-olds. No age differences were found in the children's ability to draw the baseline accurately, but older children were consistently more exact than the younger ones in reconstructing oblique lines and representing angle size. This finding is consistent with research reported on the acquisition of diagonality and the oblique effect (Olson, 1970; Goldstein & Wicklund, 1973; Berman, Cunningham & Harkulich, 1974) that reconstruction of the oblique is more difficult than that of the vertical and horizontal and is acquired at a later stage.

Inhelder (1968) has proposed the view that the older mildly retarded are fixated at the concrete operational stage. Inhelder's notion of fixation of thinking implies that during the later part of the developmental period "when one could have expected continued cognitive growth, they gradually decelerate, become fixated at a terminal stage, and exhibit no further progress" (Robinson & Robinson, 1976, p. 255). In the present study, the absence of the significant interaction and the significant age effect indicated that there was no early deceleration in the abilities of retarded adolescents on abilities tested in this experiment. This finding is not inconsistent with the Piagetian view of mental retardation. The thought processes of the 14-year-old mild and borderline retarded adolescents in the present study were probably still at the concrete operational stage and further developmental progress could still be expected. This explains the observed linear trend of the growth in copying accuracy across age groups which paralleled that observed in the nonretarded subjects.

The regression analysis revealed a strong relationship between perceptual-motor functioning, assessed by the subjects' abilities to use a straight edge to draw lines accurately between designated points of reference, and the ability to reproduce a triangle from a given model. Competency on the copying task was strongly related to the efficiency and accuracy of perceptual-motor responses. This finding is in substantial accord with that aspect of Piaget's theory which asserts a close link between the coordination of actions and the reconstruction of perceptual schemes. It is important to note, however, that although a significant proportion of the variation in copying ability was related to perceptual-motor efficiency, a substantial proportion of criterion variance was left unexplained. It may be that more effective measures for perceptual-motor functioning need to be devised. Alternatively, it may be that other cognitive or perceptual variables contribute to efficiency in copying tasks of this kind.

There was no unique subject-category effect in the regression analysis, and this was probably one of the most important findings in the present study. The perceptual-motor ability, age and subject-category variables were shown to have substantial common variance, so much so that the retarded-nonretarded contrast did not have a unique effect after the two variables had been partialled from the analysis. In essence, this result indicates that perceptual-motor ability and age were sufficient in themselves to predict competency in estimating line length and angle size. The general outcome of these results is in marked agreement with a developmental view of retardation, at least in respect to the growth of the perceptual abilities that were the concern of this study. There was a strong linear trend across age groups, and nothing to indicate different patterns of growth for retarded and nonretarded subjects. The absence of an age x ability-group interaction, and the lack of a significant and unique ability-group effect in the regression analysis lend support to this interpretation.

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CONTINUITY AND DISCONTINUITY IN COGNITIVE DEVELOPMENT: AN INFORMATION PROCESSING VIEW

J.G. Wallace
Deakin University

Discussion of the relative importance of continuity and discontinuity in cognitive development arises from a range of developmental features identified by empirical studies. The features include the ability to "go beyond" the specific content of experience and produce novel behaviour, the occurrence of curvilinear development, horizontal, and vertical décalage and the range of individual differences in the course of cognitive development.

The work to be reported is aimed at the construction of a sufficient theory of transition in cognitive development, expressed in the form of a computer program and capable of producing performance characterised by these developmental features. Its significance for the continuity--discontinuity issue is that the theory reflects the general hypothesis that development is a monotone, continuous process which gives rise to performance characterised by surface features interpretable as evidence of non-monotone, discontinuous development. In the present paper the core of the transition theory will be briefly described and an example will be provided of the type of explanations that it provides of the developmental phenomena.

A model of transition

The representation of regularity. The detection of regularities in environmental interaction and their incorporation in the child's representation of his world in long term memory (LTM) are central features of the model of transition. The processes of detection and incorporation are carried out by generally applicable self-modification processes which are assumed to be part of the child's innate endowment. Their operation is governed by a least-effort or processing-economy principle. The rationale for its adoption is presented in a detailed discussion of memory architecture by Klahr and Wallace (1976). In brief, the memory architecture is considered to combine a number of short term memory (STM) buffers or workspaces of severely limited capacity with a long term memory (LTM) which for practical purposes may be regarded as infinite. These characteristics place a high premium on making the symbols processed as information laden as possible and on avoiding any unnecessary processing.

The detection of regularities in the child's interaction with the environment provides the basis for increasing the information load of individual symbols. When a consistent sequence of processing is identified an addition may be made to the LTM world model. This consists of a conjunction of the processes involved in the sequence and is stored at a location represented by a single symbol. In future when the appropriate context is encountered the processing occurs as a result of the activation of the new aggregated representation with a consequent reduction in the symbol manipulation required in STM. In pursuit of further processing economy a general strategy is followed of extending as far as possible the area of application of each new aggregated

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representation added to LTM. This process of generalisation occurs both during the construction of a new representation and its subsequent operation. If inappropriate extensions are attempted the resulting negative feedback from the environment leads to modification of the activation conditions of a representation to enable the necessary discrimination to take place.

The general effect of this extension strategy must be viewed in the context of the LTM structures which provide a basis for representation of the world. LTM is regarded as being heterarchical rather than hierarchical, (Baddeley, 1978). That is to say it has a disconnected graph structure made up of a large number of subsidiary networks of subsystems. Subsystems are constructed by the processes of regularity detection and aggregation representation already described. They bear a broad resemblance to the "frame" type of experiential grouping (Minsky, 1975) since they correspond to particular recurring contexts. Control of behaviour shifts from subsystem to subsystem with movement from situation to situation. In conjunction with the extension strategy the heterarchical LTM structure creates a situation in which resolution of conflict arising from "domain overlap" assumes a key function in developmental transition. When a new aggregated representation is added to LTM a subsystem is augmented and set in an extension mode. This leads to attempts to generalise its application into the domains of other subsystems relevant to related contexts. Before environmental feedback leads to discrimination between appropriate and inappropriate extensions the domain overlap phase may adversely affect performance due to overgeneralisation of the subsystem operating in the extension mode.

The avoidance of unnecessary processing. In the extension strategy processing economy is sought by maximising the area of application of new aggregated representations added to LTM. The process of generalisation depends on the preceding processes of differentiation and integration which underlie the construction of aggregated representations. An alternative method of achieving economy in processing is to avoid engaging in unnecessary differentiation and integration. In the model of transition this objective is pursued by adoption of the general principle that in interaction the environment should be coped with in as large or global units as possible consistent with the preservation of effectiveness. Breaking up or analysing the environment by differentiation into smaller or more finely grained units is only resorted to when negative feedback from the environment indicates that it is necessary.

Having outlined the general principles governing the structure of the model of transition this brief description will conclude by providing an indication of its main operational features.

The time line. As indicated above, the transition processes are responsible for the construction and modification of the LTM world model. Discharging this function requires the ability to monitor the results of environmental interaction. The means adopted is a *time line* or episodic memory which contains a sequential record of the child's activity. If any regularities exist in interaction with the environment they are represented in the time line. Self-modification takes place through the detection of this regularity by the transition processes and the subsequent addition to LTM of processes which will capitalise upon it.

The mode of representation of regularity in the time line is directly derived from the nature of the LTM world model. This is composed of a large number of networks or subsystems. Each node in the LTM network represents the definition of a potentially active unit of knowledge or feature of the world model.

The time line record is compiled concurrently with the flow of processing activity. As each node is activated, a token pointing to it and tokens representing the input which satisfied the conditions for its activation are placed in the time line. At the conclusion of its activity tokens representing the output produced by the node are also inserted in the time line before the node becomes inactive and the episode terminates.

The process of regularity detection. The initial step in appropriate self-modification of the LTM world model is the identification of stretches of the time line sequence which constitute significant, novel experience. An experience list which is a feature of each node provides a means of assessing novelty. Each entry on the experience list comprises a sequence of tokens beginning withthe token for the node at which the experience list is stored. The sequence of tokens represents a description of a sequence of episodes representing states and transformations which has been detected with a significant degree of consistency in previous processing of the contents of the time line.

The decision as to whether any novel stretches of the time line are to be regarded as significant experience is entirely determined by the degree of consistency in the processing sequences they represent. Consistency detection is an aspect of the transition model which contains probablistic features. The first of these is the M(atching I(ndex) C(riterion) (0-1.0). The MIC is accorded a constant value for each individual and is regarded as varying between individuals. It is considered to reflect the operation of the neurophysiological/neurochemical rather than psychological level of functioning. The MIC determines the level of agreement between episodes before two episode sequences are regarded as a match. A key feature of the MIC for the transition process is that it permits partial matching. Provided that the surrounding context within an episode sequence is sufficiently consistent to satisfy the prevailing MIC value information on the correspondence in the occurrence of apparently mismatching tokens and episodes is incorporated into the representation of consistent sequences. This information is stored on ANYOF lists and, as will become apparent below, performs a crucial developmental function.

The decision on whether the regularity detection process has constructed a sequence representing a significant level of consistency hinges on the C(ritical C(onsistency) L(evel). The CCL is a second neurophysiological/neurochemical variable representing sensitivity to consistency. It is a critical dimension of individual differences in inductive learning and, unlike the MIC, also exhibits intraindividual variation between time line review periods. The CCL reflects both the number of time line stretches and the degree of agreement between them which must be subsumed by a sequence before it is considered to be significantly consistent.

The experience list review. The addition of a new consistent sequence to an experience list does not immediately lead to modification of the LTM world model. The influence of experience list sequences on LTM is determined by their success rate in matching stretches of time line content during the phase of the review process aimed at identifying familiar experience in the service of highlighting the results of novel interaction. Decisions on the appropriateness of LTM modification are taken when an experience list sequence as a result of a series of time line comparisons reaches a point at which it exceeds a threshold level of consistency derived from the current value of the CCL.

The entires on the ANYOF lists included in a sequence which has attained the criterion saliency level are initially submitted to a winnowing process to remove individual tokens and complete lists with relatively low frequencies of occurrence. With this accomplished an attempt is made to discover one or more type nodes representing a higher level of generality which subsume members of the ANYOF lists in the specific context represented by the sequence. The information necessary to carry out this operation is a feature of every type node in LTM. If a node representing a higher level of generality is discovered its token is substituted in the ANYOF list for the tokens of the members which it subsumes. This generalisation process may directly give rise to aggregation by initiating the addition to LTM of a new type node representing a combination of a number of existing type nodes.

Subject to the cumulative effects of earlier phases in the review process a salient sequence may itself provide the basis for the addition of a new type node to LTM. The new node is defined in terms of the nodes responsible for the appearance of the consistent sequence in the time line. This addition represents significant aggregation since results previously involving the identification and activation of a number of nodes will in future be achieved as a result of a single LTM search and node activation. An attempt is, also, made to generalise the application of the new node. The nodes which it includes are investigated to discover if they have been subsumed by more general nodes in the specific context represented by the salient sequence. If this search is successful tokens for the nodes representing a higher level of generality are incorporated in the definition of the new node.

In this brief account of the transition model emphasis has been placed on features relevant to the explanation of the developmental phenomena listed at the outset. The features include the interaction of the processes of aggregation and generalisation, the extension strategy, the heterarchical structure of LTM, the avoidance of unnecessary processing and the function of the MIC and CCL parameters. Since a comprehensive discussion is impossible, the import of the model for the developmental phenomena will be illustrated in a brief discussion of curvilinear or U-shaped development.

Curvilinear or U-shaped development

U-shaped phenomena involving identical tasks. The attempt to construct a model of transition sufficient to explain monotone development has resulted in the inclusion of four aspects of the model conducive to the appearance of U-shaped developmental phenomena. Two aspects are relevant to the situation in which the U-shaped development is defined by three successive performances on an identical task. In the remaining two similar rather than identical tasks are employed.

The strategy of avoiding unnecessary differentiation and integration by adopting as a general principle that the environment should be processed in as global units as possible has two negative consequences. In some cases the level of differentiation represented by the global state may be totally incompatible with effective environmental interaction; in others it may lead to success in coping with some but not all aspects of a content area. For the present purpose the latter situation can be regarded as an over-extension of the domain of a child's initial method of coping with an aspect of the environment. Such over-extension will result in negative environmental feedback leading to an attempt to derive a satisfactory method of coping. This proceeds by means of an increase in the level of differentiation achieved via the regularity detection processes and culminating in the addition of a new method of coping to the child's repertoire in LTM.

Consistent with the extension strategy an attempt is made to generalise application of the new method as far as possible across the relevant context. This, in turn, may result in over-extension if it is applied to aspects of the content area for which the initial rather than the new method is appropriate. Resolution of this situation involves removal of the overlap between the domains of the two coping methods. This is brought about by environmental feedback which enables discrimination of their respective areas of applicability and appropriate modification of their activation conditions. The sequence of developmental steps outlined would give rise to U-shaped performance data with successive administrations of a task falling within the domain of the initial method of coping.

The second source of U-shaped performance data on identical tasks is much more sensitive to the specifc timing of the data gathering, and, as a consequence, is much less likely to be detected. Creation of a new type node in LTM either as a consequence of ANYOF list processing or on the basis of a salient sequence involves a considerable amount of processing of existing nodes to obtain the necessary information. Task performance controlled by any of these nodes might well be adversely affected if the data was collected concurrently with the process of new node creation. This very temporary regression would result in a short lived U effect.

U-shaped phenomena involving similar tasks. The two remaining aspects of the transition model to be considered can be distinguished from those relevant to the identical task situation in that they give rise to regression in performance which is apparent rather than real. Apparent regression arises from a mismatch between an observer's expectations of children's level of performance across tasks deemed to be similar and the nature of the subsystems of subsidiary networks in LTM which govern the nature of the children's responses. Failure to take account of the effect of a heterarchical LTM may result in the employment of test situations which are considered to be variants of the same task but actually depend on the activation of different subsystems for successful performance. Since relevance to closely related contexts is no guarantee that subsystems will develop at the same rate apparent regression may be observed if a task variant tapping a more swiftly developing subsystem is administered to a child then followed by a variant leading to the activation of a more slowly developing subsystem. An example of the type of subsystem relationships which may give rise to such observations is provided by the development of the processes underlying conservation of discontinuous and continuous quantity (Klahr & Wallace, 1976). An analysis of subsystem terms of the demands of the tasks employed by Mehler and Bever (1967) in obtaining their famous U-shaped data is presented by Wallace (1972). This indicates that they not only call upon distinct subsystems but on occasions activate two or more subsystems within a single task.

Consideration of the heterarchical LTM structure underlying performance highlights the importance of the MIC and CCL parameters. Variations between individuals in the value of the MIC and the range of CCL values may produce marked differences in the rate of development of subsystems and in the location of the boundaries between subsystem domains. Their importance is emphasised by the nature of the second source of apparent regression. Like its predecessor this hinges on the observer's definition of task similarity and the performance expectations arising from it.

A specific example of the type of regression involved has been provided by Bower (1978) in his explanation of the apparently developmentally regressive effects of thorough training. The general sequence of events underlying the observations is as follows. A child's experience of a situation results in the detection of a consistent sequence in the time line and its incorporation in an experience list. If the experience is protracted the level of detail in the time line representation of the same sequence of events increases greatly. This effect is particuarly marked in individuals with relatively high MIC and CCL values. This increase, in turn, results in an increase in the specificity of the experience list sequence as comparison with the time line content proceeds. Continued experience ensures that it is a highly specific version of the sequence which eventually forms the basis for the addition of a new node to LTM. Here it may become a source of data which may be interpreted as a regression in level of performance. Tasks similar in highly specific detail to those featuring in the environmental interaction giving rise to the node will be successfully performed. If other versions of what to an observer appear to be the same or highly similar tasks are presented subsequently the performance level will fall since the specificity of the representation at the node prevents its activation by situations which differ from it at a detailed level. Such similar situations will not be coped with successfully until additional interaction results in the construction of nodes adapted to their requirements. The node combination process may, in due course, lead to the construction of a new node subsuming some or all of these nodes relevant to closely related contexts.

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PHENOMENOLOGICAL EVIDENCE OF EIDETIC IMAGERY IN CHILDREN[1]

Leslie J. Harris and Alan Richardson[2]
University of Western Australia

In 1819 Purkinje drew attention to the phenomenon now known as eidetic visual imagery. This is a class of vivid imagery reported to follow the presentation of a visual stimulus. Eidetic imagery is considered to occur sporadically in primary school children. Its incidence in adult populations is believed to be quite rare.

A recent theoretical analysis of eidetic imagery by Haber (1979) drew only one firm conclusion: Research into the phenomenon should not be abandoned. A robust theory is yet to be discovered. The main advance of the last two decades has actually been standardisation of the criteria for differentiating eidetic imagery from other related phenomena.

Distinguishing features of eidetic imagery

Eidetic images are not just vivid memory images. Eidetikers remain oriented to the place where the original visual stimulus was seen in order to "see" their image. The image is seen in the same sense as a percept is seen. For example, both eyes move to the left when objects on the left side of the image are described. Furthermore, the experience of reporting the contents of an eidetic image is not like any memory experience. The information contained in an eidetic image is not considered to be retained from the past. It is still to be attained from the image. In other words, information stored via an eidetic image is not experienced to be "known" until attention is focussed on that aspect of the image.

Eidetic images are not after-images. One reason is that they are not suppressed by vigorous eye movements which are made when scanning both the visual stimulus and the subsequent eidetic image. These eye movements may actually enhance the clarity of an eidetic image. A second distinguishing factor is that eidetic images have considerably longer duration times. It is common for an eidetic image to remain for in excess of five minutes in conditions where an after-image has faded within 20 seconds. Finally, unlike most after-images, eidetic images are positively coloured.

Eidetic images are not simply literal copies of the original visual stimulus. Some of the visual details are omitted or rearranged. Completely novel features can be incorporated into the resultant eidetic image. These are not errors in the usual sense of recall errors. Eidetikers can be fully aware of the differences between the original presentation and their image. A further point which illustrates that eidetic images are not passively photographic is that they are best induced when the visual stimulus is coherent and of interest to the observer. Eidetic ability may well be inhibited by the presentation of an unstructured montage.

Subjects and classification criteria

We have recently tested 200 primary school children individually for eideticism. The age range in this sample was from five to nine years. Of these children, 14 have been classified as having considerable eidetic ability. This classification was based upon the seven criteria which were initially proposed by Haber and Haber (1964). These criteria, which were applied to responses to four different stimuli, were used to indicate the presence of eidetic imagery while differentiating it from memory, after-imagery and demand characteristics. The criteria are:

(1) that the duration of the image is longer than 40 seconds which is longer than is considered likely from after-images of comparable stimuli;

(2) the child reports that an image is seen;

(3) the image is reported to be located in front of the eyes on the plane of the visual stimulus;

(4) the present tense is used to describe the image but a shift to the past tense is made to describe from memory those parts that have faded or that were not in the image;

(5) eye movements are made during inspection of the stimulus in order to reduce the likelihood of subsequent after-imagery;

(6) eye movements are made during inspection of the image; and

(7) accuracy of detail is better than would be expected from normal memory.

The first three criteria are phenomenological because they depend upon our acceptance of the report that an image is "seen" and is externally located. The other four are included as checks on the phenomenological descriptions. But they are not very good checks. Many children tend to use tenseless phrases during their reports, eye movements become difficult to assess over time periods greater than about 10 seconds and accuracy of detail is not always so high because, as mentioned earlier, eidetic images are not photographic. Nevertheless, all seven criteria were used in selecting eidetikers in order to allow comparison between the present sample and samples described in other studies. Haber (1979) pooled the results from previous studies with normal school children that have used these seven criteria and reported a mean incidence of 5%. The 7% found in the current sample compares favourably with this estimate. The 95% confidence interval about this 7%, derived from the cumulative binomial distribution, ranges from an incidence of 5% to 11%.

Because of the problems inherent in the four criteria which serve as checks on the phenomenological reports there is the possibility for argument as to whether eidetic imagery exists at all. A devil's advocate may suggest that the small proportion of a sample of children which contains those classified as eidetic could be the few that deliberately lie about what they can see, or are the ones that confuse seeing and remembering, or are those children who are most susceptible to the suggestion by the experimenter that they can still see something. The purpose of this paper is to present a preliminary report of data that may be used to evaluate these alternative hypotheses. These data are in the form of videotape recordings made of each of the 200 children while they were tested. This data base is far richer than that which has been available up until now because previous studies (e.g., Leask, Haber & Haber, 1969) have relied upon only audio recordings of phenomenological reports.

Method

The testing procedure adopted for this study is essentially the same as that used by Haber and Haber (1964). This procedure has become the accepted standard in eidetic imagery research over the last 20 years. The major difference between our procedure and Haber and Haber's is in stimulus presentation. Like Paivio and Cohen (1979), we presented stimuli on slides using a slide projector, whereas Haber and Haber physically mounted their stimuli on an easel.

Subjects were seated approximately two metres from a white screen upon which the stimuli were projected. The slide projector was positioned just behind the subject's right shoulder. The procedure began with an elicitation of an after-image to a small black square, in order to provide an example of what is meant by "still seeing" something that is not physically present. This was followed by the eidetic testing, which involved displaying up to four different pictures for a duration of 30 seconds each. These are illustrated in order of presentation in Figures 1, 2, 3, and 4.[3] Immediately after each display, the child was asked to describe any images observed. The following is a representative excerpt of such instructions transcribed verbatim from one of the videotape recordings.

> E: When I turn the projector off I want you to keep on looking and tell me if you see anything there or not. But for now just keep on looking at all over the different things in that picture very carefully. I'll soon be turning the projector off, keep looking though. O.K. Here we go. (Turns the projector off.) Keep looking. Can you see anything there now?

Following the description of any images, the child was then requested to recall the contents of the picture from memory.

Results

The reaction of a non-eidetiker (subject 195, a 9-year-old boy) is presented first in order to provide an indication of the modal response. This transcript is of an excerpt of the videotape recording where the subject reported what he saw after the projector, which was displaying the first picture in the series (Figure 1), was turned off. The subject's memory recall for the picture is not included. It was quite accurate and complete.

> E: (Turns the projector off.) Keep looking. Can you see anything there now?
> S: (Pauses, then shakes head) No. I can't see nothing.
> E: O.K. Are you sure?
> S: Yes (nods).
> E: You can just see the white screen there now?
> S: Yes!
> E: O.K. What happened when I turned the projector off that time?

Figure 1

First picture in the presentation: silhouette of a cartoon policeman and pig.

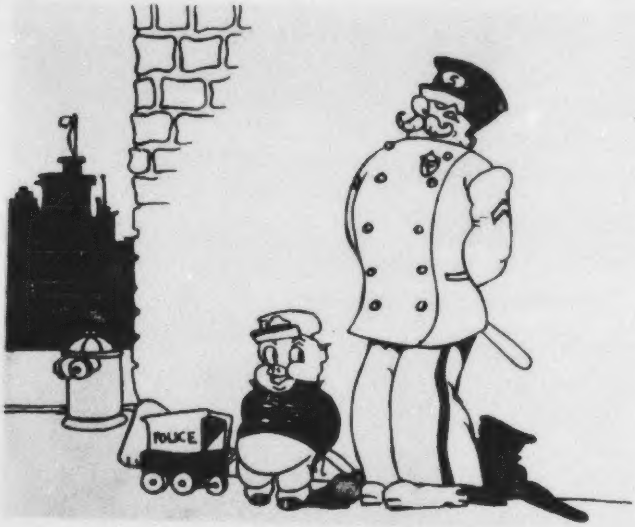


Figure 2

Second picture in the presentation: silhouette of a duck in a striped coat and three flowers.

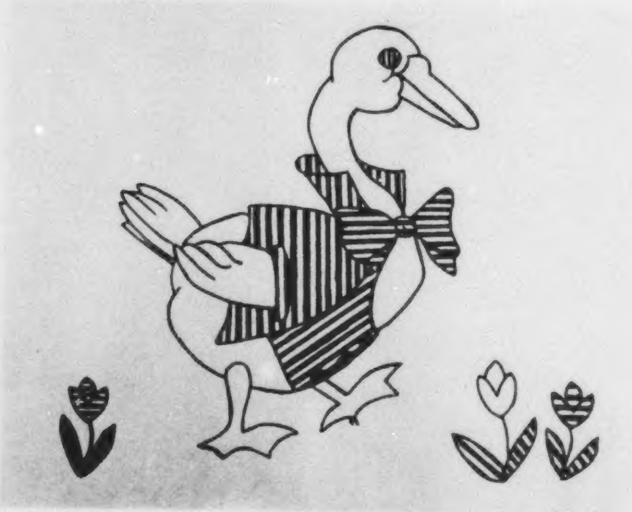


Figure 3

Third picture in the presentation: snow scene in full colour.

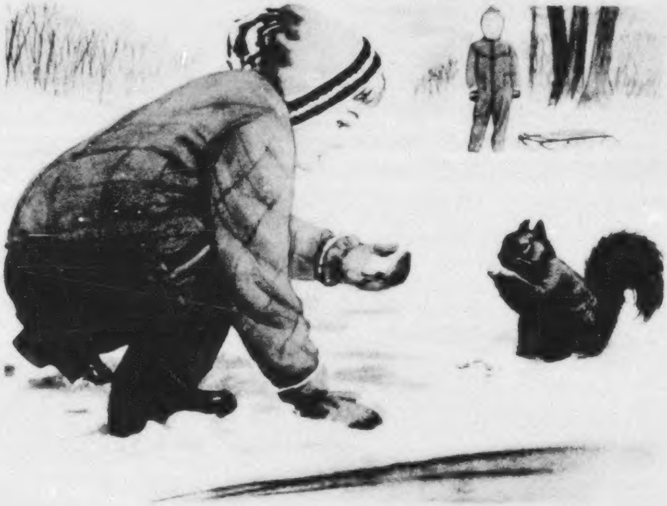
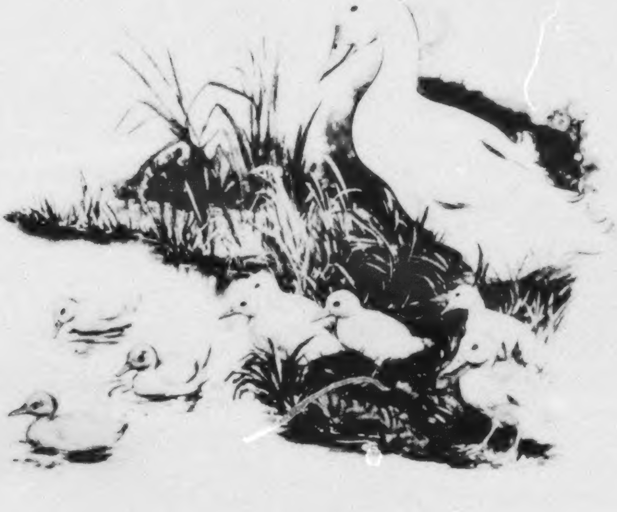


Figure 4

Fourth picture in the presentation: ducks at a pond in full colour.



S: I just saw (pauses) it just went off.
E: It just went off did it?
S: (Nods)

The first eidetiker discovered in this study was a 6-year-old girl (subject 5). The next transcript contains her report of her eidetic image to the first picture (Figure 1), followed by her recall of the picture from memory. Her eidetic performance for the second picture (Figure 2) is also presented. This serves to illustrate the typical consistency of eidetikers across different stimuli.

E: (Turns the projector off) Can you see anything there?
S: Sort of (nods). Sort of the shape of that big (hesitates) pirate and ...
E: Is it still there?
S: (Nods) Yes.
E: Good. Keep on moving your eyes because you might find that keeps the shape there. So you tell me when the shape goes.
S: (Hesitates) He's sort of faded.
E: Yes. Has it gone now or is there still bits there?
S: (Squints) It's still going.
E: O.K. You keep looking and you tell me what you can see. Keep on telling me what you can see.
S: There's a building over there (points accurately) with a flag on it.
E: Yes (pauses). What else?
S: (Continues to point) Sort of the pig down there.
E: Yes, and what else?
S: (Points) Bricks up there.
E: Yes. Keep on describing it to me until it goes.
S: It's sort of gone now.
E: Has it gone now? Altogether?
S: Not all of it (shakes head). The building and the flag and the bricks (points) are still there.
E: O.K. You keep telling me. Keep reporting about it. Tell me what you can still see. Tell me what else you can see there.
S: I can see a pig with (hesitates) sort of buttocks behind him.
E: Yes. That's very good. Anything else?
S: And the buttons are still there (points) on that big (hesitates) pirate.
E. Yes.
S: That's mostly that's darkest on that pig, that big pig ...
E: Yes.
S: ... whatever.
E: Yes.
S: And I can't see anything now (shakes head).
E: Has it gone now?
S: Yes (nods).
E: O.K.

The text of the subject's memory report for the same picture follows below. Note here the change from present to past tense.

E: Can you see anything else?
S: No.
E: Now what can you remember from that picture?

S: (Looks away from the screen and towards E) That there was a pig.
E: Yes.
S: And there was (hesitates) a building with a flag on it.
E: Yes.
S: And there was some bricks with a shape. There was just a few bricks, about eight.
E: Yes.
S: Or maybe a bit less.
E: Yes.
S: And what else was it? And there was those trucks behind it.
E: Yes. Talk up just a little bit, a weeny bit more just so that the recorder gets you because I want to go through this and hear everything you say.
S: And then there was that big sort of man or whatever it was ...
E: Yes.
S: ... with the jacket on and buttons, three buttons.
E: Anything else?
S: And the building had lots of bricks on it (draws outline in space).
E: Yes.
S: Twelve bricks.
E: Yes. You've got a good memory.

The subject's report of her eidetic image to Figure 2 is presented in the following text.

E: (Turns the projector off) O.K. Keep going. Tell me what you can see.
S: The shape of (hesitates) the duck and their flowers.
E: And you can actually see that there can you?
S: (Nods)
E: Good. You tell me when it goes. You keep telling me.
S: ... then there...and the duck has a jacket on.
E: Yes.
S: And two of the flowers I can see have stripes on.
E: Yes.
S: And the flower that is white has (hesitates) one line on it.
E: Yes.
S: And the other side is stripey like the two flowers.
E: Yes. Good.
S: And there's a beak on the bird ...
E: O.K.
S: ... the duck.
E: Yes. Can you point to these things as you say them?
S: (Points to where she sees the beak)
E: That's a good girl.
S: (Points) There's the duck. And there's its head and there's its beak.
E: Yes.
S: (Continues to point) One flower's there and two flowers up there.
E: Yes.
S: (Still pointing) And (hesitates) the (hesitates again) white one's there, the striped one's there, and the other striped one's there.
E: Yes.
S: (Points) And the coats are there.
E: Yes.
S: (Points) And there's its wing. That's all I can see. It's sort of fading.

E: O.K. Is it still there now, bits of it?
S: Bits of it.
E: O.K. Tell me the bits that you can see.
S: (Hesitates)
E: Keep on pointing. That might be a good idea too.
S: (Points) And I still see its legs.
E: That's right, because you're drawing them for me and that helps.
S: Yes.
E: Yes.
S: (Points) And there's (hesitates) ... I still see the flowers that have stripes but other one has gone.
E: Yes.
S: And the jacket has almost gone.
E: O.K. (Pauses) Can you see anything else?
S: That's all I can see.

The next subject, a boy aged seven (subject 126), provides a further example of an eidetiker reporting an image for the first picture. Note his lack of response to suggestion. In addition, note his introduction of two novel and previously unseen figures into his image.

E: (Turns the projector off) Here we go. Keep on looking. Can you see anything there now?
S: Yes.
E: What can you see?
S: Just the same picture as there was on the screen.
E: O.K. Can you point to the things and tell me what you can see?
S: I can see a pig with a policeman.
E: Can you point to that for me?
S: A pig with police hat, it was (points) just down there.
E: Is it there now?
S: Yes.
E: O.K. What else can you see? Tell me what you can see right now and point to it.
S: Now I can see a big policeman that's a bulldog ...
E: Yes.
S: (Points) ... standing up.
E: Yes.
S: And I can see a brick wall. And that's all.
E: Can you point to the brick wall for me?
S: It's just up there (points) going up like that.
E: O.K. How many stripes does the policeman have on each arm? Can you see that?
S: About six.
E: Lots of stripes?
S: Yes.
E: Can you point to those?
S: (Points) They're just on his left shoulder.
E: I see. And can you read what's written on his badge?
S: No.
E: Can you point to his badge?
S: Yes (points) it's over near his right shoulder.
E: O.K. Tell me when it all goes. Can you point to the policeman's big nose?
S: Yes (laughs a little).
E: Can you do that for me?
S: (Points) It's just up there.
E: O.K. Can you count the buttons on the little pig?

S: Yes.
E: Can you point to those for me?
S: (Points) One up there and one down there and one down there. Three!
E: Good boy. How many wheels are there on the little cart? Point to the cart for me.
S: I can only see three. (Points) One there, one there, and then one back there.
E: Oh, I see. O.K. That's good. Can you point to the flag on the castle? Can you see a castle there?
S: No I can't.
E: You see where the wall is?
S: (Acknowledges)
E: Just to the left of that there might be a castle there.
S: I can't see any castle.
E: O.K. All right. What else can you see?
S: I can see (pauses) a lady coming round the corner.
E: Can you point to her?
S: (Points) Just up there.
E: (Acknowledges)
S: And a man coming round the other side (points) just over there.
E: Are the policeman and the pig still there?
S: Yes.

Lastly, subject 124, an 8-year-old boy, illustrates the case where previously constructed eidetic images can become superimposed upon a current eidetic image. Here is a transcription of a short section of his eidetic performance recorded some five minutes after the display of the fourth picture (Figure 4).

S: Now I'm seeing the three other pictures.
E: What do you mean the three other pictures?
S: I'm seeing the picture about that squirrel and I'm seeing the picture about that pig.
E: Are you? What, all on top of one another?
S: (Laughs) Yes. (Laughs again)
E: Can you point to the squirrel for me?
S: (Points) The squirrel's right over there ...
E: Yes. Now, can you point ...
S: ... and the boy's up there ...
E: (Acknowledges)
S: ... and the girl's there ...
E: (Acknowledges)
S: ... and the duck's there ...
E: (Acknowledges)
S: (Still pointing and quite excited) ... and now little duck there, two ducks there, and the pig's over there ... (speech becomes unclear) ... and the building's over there ...
E: Yes.
S: ... and the big sergeant's over there (scratches head and smiles).
E: Oh my goodness!

Concluding remarks

A general trend noticed for the eidetikers in the present study is that eidetic ability becomes stronger with the presentation of each successive picture. This trend may serve an argument against Haber's (1979 interpretation of a longitudinal study by Leask *et al*. (1969) which was that their evidence is damaging to Jaensch's ontogenetic theory of eidetic imagery. This theory predicts that eidetic ability should deteriorate with age. Leask *et al*., on the other hand, reported that children, initially classified as eidetic, remain classified as eidetic even when retested up to the age of 15. In lieu of the practice effect demonstrated by the current sample of eidetikers, this stability of eidetic imagery may well be a product of testing which implies it is of little relevance to a criticism of the ontogenetic theory.

The second and final remark bears on the despairing result that there is no evidence that separates eidetic children from non-eidetic children on any variable other than eideticism. Haber (1979) makes the point that past research has failed to demonstrate reliable relationships between the presence of eidetic imagery and any cognitive, intellectual, neurological or emotional measure. The reason for this state of affairs is quite simple: Sample sizes have been too small. Studies that have adopted the Haber and Haber procedure have all resulted in samples with fewer than 24 eidetikers. The associations that have been reported, but which fail to reoccur on replication, are likely to be examples of mere chance encounters.

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[1] This research was supported by a financial grant made to Alan Richardson (the chief investigator) from the Australian Research Grants Committee, Number A 7915315 I.

[2] Our thanks are due to the staff and students of Nedlands Primary School. Their co-operation is very much appreciated.

[3] Figures 1 and 2 were copied from the drawings published by Morsh and Abbott (1945).

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VISUAL MEMORY IN EPILEPTIC CHILDREN

Anthony W.H. Buffery
University of Melbourne

The purpose of this study was to investigate specific problems in the processing of visual information as experienced by children suffering from epilepsy of a relatively mild nature. In the classroom the teacher frequently complains that such a child "doesn't pay attention", "has poor concentration" or is "a slow learner". The child complains that "teacher goes too fast", "I fall behind" or "I miss bits". The ultimate intention was to apply findings from the experimental study to the classroom situation, i.e., to promote "a patient-specific timetable of rehabilitation" (Buffery, 1980).

The Children

Epileptic right-handed children aged from 11 to 14 years were selected; all with learning problems as reported by their teachers and a history of minor fitting from before the age of 2 years. Six groups each of 16 children (eight boys and eight girls), with a comparable average and range of age and of Full Scale WISC IQ (ranging from 80 to 100 points), were created on the basis of the focus for the onset of epileptogenic activity as determined from the analysis of EEGs taken over the two-year period immediately prior to the study. The six groups were Left Frontal, Left Temporal, Left Parietal, Right Frontal, Right Temporal, Right Parietal. A control group of eight male and eight female normal right-handed children with a comparable average and range of age and intelligence was included.

The Tasks

The child sat facing a "touch sensitive" screen upon which were back-projected various visual-verbal or visual-spatial stimuli. On any single trial Stimulus 1 was displayed for up to 24 seconds and the child touched the centre of the display screen when he or she felt that they would be able to remember that stimulus across the immediately following eight seconds *intra*-trial delay. After this delay, Stimulus 2 was displayed for up to 24 seconds and the child touched either the *upper* border of the screen to signify that Stimulus 2 was the *same* as Stimulus 1 or the *lower* border to signify that Stimulus 2 was *different* from Stimulus 1. Response to Stimulus 2 was immediately followed by an *inter*-trial delay of 16 seconds duration (i.e., twice the length of the intra-trial delay). Response latencies to Stimulus 1 and Stimulus 2 were recorded, together with the nature and accuracy of the "match/mismatch" judgments. Two tasks, each of 128 trials, were presented to each child. One task involved visual-verbal material (Easy to Verbalise, EV stimuli), the other visual-spatial (Difficult to Verbalise, DV stimuli, Buffery, 1974). The EV stimuli were Words and the DV stimuli were Shapes (see Figure 1).

Within both tasks of 128 trials, 64 pairs of S1 and S2 were the "same", 32 pairs were "different" in "rearrangement", and 32 pairs were "different" because of a novel "subsitution" (see Figure 1). Each child was tested over two sessions each of 128 trials comprising of 64 EV and 64 DV stimulus pairs. Each session lasted approximately 100 minutes and occurred on separate days.

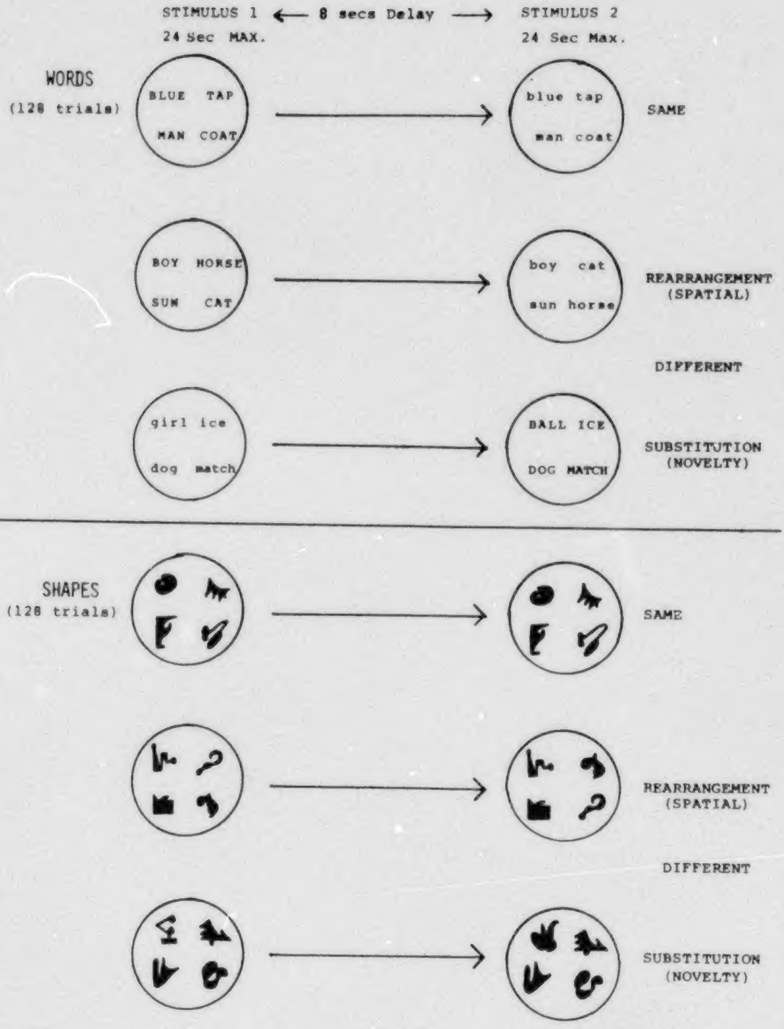
STIMULUS 1
24 Sec MAX.
8 secs Delay
STIMULUS 2
24 Sec Max.
WORDS
(128 trials)
BLUE TAP
MAN COAT
blue tap
man coat
SAME
BOY HORSE
SUN CAT
boy cat
sun horse
REARRANGEMENT
(SPATIAL)
DIFFERENT
girl ice
dog match
BALL ICE
DOG MATCH
SUBSTITUTION
(NOVELTY)
SHAPES
(128 trials)
SAME
REARRANGEMENT
(SPATIAL)
DIFFERENT
SUBSTITUTION
(NOVELTY)

Figure 1:
Examples of the visual-verbal (EV Words) and visual-spatial (DV Shapes) stimuli. Note that in the EV task (Words) within a trial the case size of the cluster of four words in S1 was different from that used in S2, (i.e., Upper/Lower or vice-versa) so as to minimise the influence of spatial cues, (i.e., comparisons had to be made on the basis of meaning rather than shape).

The results of this study are summarised in Figure 2 in terms of Mean measures for each group.

The errors for both the EV task (Words) and the DV task (Shapes) are broken down into False- (the child signifies falsely that S2 is different from S1), False+ "spatial" (the child signifies falsely that S2 is the same as S1 despite the "rearrangement" of details), and False+ "novelty" (the child signifies falsely that S2 is the same as S1 despite the "substitution" of an original detail by a novel one). Chance level is at 50% for these tasks, and the Mean Levels of performance together with the Mean length of response latency for both S1 and S2 on correct trials are shown for each of the seven groups.

The following results should be noted. Only those differences reaching a minimum of p = < .05 level of significance are emphasised (two-tailed t tests).

1. Normal children performed with over 75% accuracy on both the EV task (Words) and the DV task (Shapes), and distributed their errors equally between False- and False+ and, within the latter, equally between "spatial" and "novelty" type changes in detail. Further, for both Words and Shapes, the Normal Group's Mean response latencies on correct trials for S1 were two to three seconds longer than for S2 . . . an adaptive strategy in tasks involving attention to S1, an intra-trial delay and a decision about the identity of S2 in relation to the recollection of S1.

2. Frontal focus children performed slightly (though not significantly) better than Normal children, i.e., at an over 80% level of accuracy. They also made fewer False+ than False- errors, and very few False+ "novelty" errors indeed, i.e., they usually perceived a change between S1 and S2 and particularly if that change was produced by the substitution of an original detail by a novel one. For both Words and Shapes the Frontal Group's Mean response latencies on correct trials for S1 were around six seconds longer than for S2 . . . again an adaptive strategy in such tasks.

3. Left and Right Temporal focus children performed differently from each other (and from other groups) according to the nature of the visual material.

On the EV task (Words) Left Temporal focus children were impaired relative to all other groups, including the Right Temporal focus group, i.e., around 60% accuracy compared with over 70% accuracy. However, on the DV task (Shapes) Right Temporal focus children were impaired relative to all other groups, including the Left Temporal focus group, i.e., around 60% accuracy compared with over 75% accuracy. The Left Temporal focus group in the EV task (Words) and the Right Temporal focus group in the DV task (Shapes) made approximately twice as many False+ errors as False-. The Mean response latencies on correct trials for S2 by the Left Temporal focus group in the EV task (Words) and by the Right Temporal focus group in the DV task (Shapes) were over seven seconds longer than their respective Mean response latencies for S1 . . . a *maladaptive* strategy on such tasks since increasing the length of time spent in the presence of S2 effectively increases the length of intra-trial delay across which the recollection of S1 has to be made.

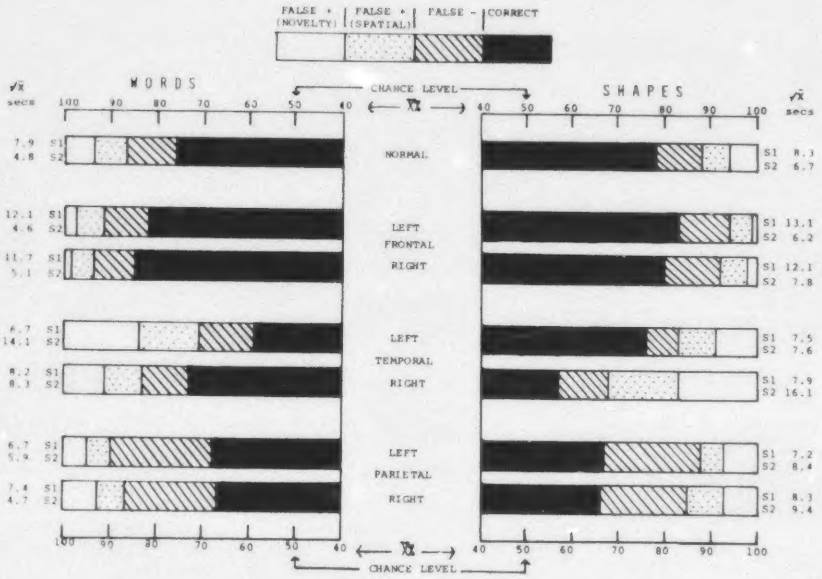

Figure 2:
Performance on the EV (Words) and DV (Shapes) delayed paired comparison tasks in terms of Group Mean percentage of correct, false-, false+ (spatial) and false+ (novelty) responses, and of Group Mean response latencies on correct trials to S1 and S2.

4. The Left and Right Parietal focus children performed poorly on the EV (Words) and on the DV tasks (Shapes) compared with all other groups (except, of course, the Left Temporal focus on the EV task and the Right Temporal focus children on the DV task), i.e., at around the 65% level of accuracy. They also made approximately twice as many False- errors as False+ throughout. However, their Mean response latencies to S1 and S2 on correct trials were close to those of the Normal children.

Discussion

It should be noted that, despite expectations, the present study produced neither sex differences nor any evidence for reversed cerebral predominance for verbal skills despite the emergence of abnormal dysfunction within half the children's left cerebral hemisphere prior to the age of two years (for discussion of these issues see Buffery, 1971a; Buffery & Gray, 1972). Perhaps equivalent auditory memory tasks would have been more sensitive to sex differences and to any reorganisation of the brain's functional topography.

The present delayed matching task is an exercise in the registration storage and retrieval of visual information and it is clear that the focus for the onset of cerebral epileptogenic activity determines the nature of the difficulty experienced by the epileptic children regardless of their sex or range of intelligence and age.

Frontal focus children performed well on both the EV (Words) and DV (Shapes) visual memory tasks partly because they strengthened registration by increasing their length of reponse latency to S1. Frontal focus children were particularly adept at noticing differences between S1 and S2 that reflected a change in novelty. Both increased response latencies at the time of registration and attention to novelty were characteristic of the performance of lower primates on a delayed matching-to-sample task following bilateral lesions of the frontal lobes (Buffery, 1966, 1967).

The difficulties of the Left vs Right Temporal focus children were material specific, i.e., with EV (Words) and DV (Shapes) respectively. The Temporal focus children appeared to have difficulty at the stage of retrieval in that they showed an increased length of response latency for S2. They also made approximately twice as many False+ errors as False-. Consequently, in their respective material specific deficit, Left and Right Temporal focus children exhibited a high threshold for the perception of change in that they overgeneralised their "same" responses to trials where S1 and S2 were "different". A maladaptive increase in the length of response latencies at the time of retrieval was characteristic of the performance of lower primates on a delayed matching-to-sample task following bilateral lesions of the temporal lobes (Buffery, 1964, 1965).

Both the Left and Right Parietal focus children were impaired on the EV (Words) and DV (Shapes) tasks, and made approximately twice as many False- errors as False+, i.e., they exhibited a low threshold for the perception of change in that they overgeneralised their "different" responses to trials where S1 and S2 were the "same".

Strategies for Instruction

These results suggested strategies for classroom instruction when primarily visual-verbal or visual-spatial information is being presented for future recall. Here is a selection of the more fruitful strategies.

1. Frontal Group (EV and DV tasks). Repetition at the time of self-paced registration and the maintenance of attention by the use of relatively unfamiliar (i.e., more novel) materials.

2. Left Temporal Group (EV tasks): Right Temporal Group (DV tasks). Introduction of strategies for encoding input into storage that facilitate discriminability at the time of retrieval so as to lower threshold for the perception of change.

3. Parietal Group (EV and DV tasks). Overlearning at the time of registration by such exercises as copying and immediate recall in order to overcome the progressive "distortion" of the memory traces in storage and thereby raise the threshold for the perception of change.

Conclusions

Boys and girls with minor epileptic symptomatology who had been subsumed under the rather general, somewhat meaningless and heuristically useless category of "learning disordered" were shown in this investigation to vary considerably in their abilities at the various stages of information processing and also in their vulnerability to different qualities of material. These differences in the patterning of the children's ability to perceive change in visual-verbal and visual-spatial stimuli were related to the focus for the onset of epileptogenic activity and not, within the ranges of this study, to their age, sex, or intelligence. Consideration of the individual child's particular difficulties in the registration, storage and retrieval of Easy to Verbalise and Difficult to Verbalise information can lead to more appropriate "pupil-specific" teaching strategies. A further study of epileptic children similar to that described here, but involving the auditory modality, is in progress. It is probable, however, that studies involving cross-modal integration will produce even more apposite data upon which to build educational therapies (Buffery, 1971b, 1976, 1977; Buffery & Waterson, in press).

Acknowledgements

The authors thanks Christine Buffery and Tracy Menhennet for their help with this paper.

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SOME CURRENT ISSUES IN EXPLORING DEVELOPMENT

Jacqueline J. Goodnow
Macquarie University

I have two goals in mind for today's material. One is to provide a brief look at some current research at Macquarie. The other is to provide an overview of some general trends in developmental work, predominantly in the U.S.A. Fortunately, those goals are interrelated.

As a start, let me comment on three general trends. The first touches on style and on the study of gender differences. The question has been raised of variety in the accents heard here. More widely, conference-goers (and readers of papers) watch with equal interest as people struggle with gender when referring to children. I have heard at this conference "the child ...he", "the child...she", "the child... he or she", and "the child...it". "The child...he" is a low frequency event in the United States these days. In fact, new graduates looking for jobs are often advised to avoid it or risk appearing, at least, out of date. Also low frequency is a solution I have not heard here at all, namely John Flavell's tendency to use sometimes "he", sometimes "she" in a relatively alternating fashion. If I were, in contrast, to pick solutions of rising frequency, they would be "he or she", "it" (Michael Lewis is a strong promoter of "it" and the plural "children...they").

The other two trends are more academic. The first is an increasing interest in combining "social" and "cognitive" aspects of development. The mergers may be seen, in a gross form, in the increasing frequency of such labels as "social cognition" "cognitive social psychology", or--an interesting variation from Doise (1978) in Geneva--"the social psychology of cognitive development".

The second general trend is a concern with the "setting" or "context" within which performance or development occurs. That takes a variety of forms. Some of it is directed towards analysing the demands and the impact of particular task settings. Bronfenbrenner's (1979) interest in the ecology of various settings is a prime example. I have also in mind Gelman's (1978) review of studies asking how children come to learn what she calls "the rules of the experimenter's game", or the concern of several people--Sroufe, Glick, Belsky--with how behaviour observed in a laboratory situation compares with behaviour observed at home (e.g., Belsky, 1979). At the other end of the scale, an interest in setting appears in the emphasis on considering the effect of the historical period or the nature of the economy. An example of interest in both of these settings is the argument by Rosenkrantz (1978) that concepts of children as too young and delicate to work at ages 7 or 8 years coincided with the declining need for children on the labour markets of industrial England.

Now an interest in settings makes intuitive sense. But it carries some problems with it. Take, for instance, the question: How is one setting related to another? It is often said, for example, that to understand the mother-child dyad we have to consider it in the context of the whole family. That has left a number of people struggling with ways of describing with any precision the nature of relationships in a triad:

child, mother, father. And triads are far from being "whole families". It is also often said that we need to consider the child as existing within the settings of family, community, and "state". All three contexts for instance, are said to need considering if we are to account for a phenomenon such as child abuse (cf. Parke, 1980). That again makes good sense. But how are those several settings related to one another? How shall we describe relationships? Without some workable ways of describing relationships among settings, we shall be left almost at the level of platitudes.

The same problem applies to the question: How shall we describe the difference between one setting and another?

As a springboard, I shall take the notion that the difference between one setting and another may lie in the ideas held about children; ideas about their qualities, their needs, their probable course of development, their probable ends etc. Such ideas might range from regarding children as having a duty to learn as against having a strong wish to learn, or as being "imps of darkness" in contrast to "trailing clouds of glory".

Ideas about children have a special appeal as a starting point, in the sense that there is around at the moment an interest in both historical and contemporary variations. The interest in historical variations is, I feel sure, familiar to you through the writing of people such as Aries (1962) or Pinchbeck and Hewitt (1969, 1973). Less familiar probably is the current interest in contemporary variations, with a stress on parents' ideas about the nature of children and the nature of development. That interest is shared at the moment by a diverse set of developmentalists: Block at Berkeley, Hess at Stanford, Olsen at Michigan, Hunt and Parke at Illinois, Sameroff at Chicago, Sigel at Princeton--to name people whose current work I know of. These several investigators have in common the conviction that (a) to account for child development you need to look at parental behaviour, and (b) to account for parental behaviour you need to look at the way parents interpret child behaviour, to look at the meanings given to both what the parent and the child are doing. That stress on meanings and interpretations, you will recognise, is the message that often comes as well with the historical accounts.

We still have a way to go before we get ideas about children--historical or contemporary--into workable form. How can we take the next step? I propose that we set up some more specific questions, questions that can be related to either historical or contemporary material. These are the questions, incidentally, that have guided work at Macquarie currently being carried out by Judith Cashmore, Rosemary Knight, Graeme Russell and myself.

Some more specific questions

1. What is the content of ideas about children? General comments can be charming. We need, however, sufficient specificity to allow the comparison of one historical period with another or one group of people with another. Let me indicate some of the aspects of content we are working with at Macquarie. These are not the only aspects we are concerned with, but they will serve today's purpose.

"Timetables". The emphasis is on the ages at which children are expected to be able to carry out a variety of tasks. I am, for example, currently analysing the age-sortings given by two groups of Australian mothers, one group with an "Anglo" background, the other with "Lebanese". The comparison is promising, in the sense that both the items and the samples of mothers are providing some useful variance to work with.

Perceived stability. Several of us have been asking parents to rate the expected stability of various traits. If a child is easily distracted at age 6, for example, do parents expect that behaviour to change by age 12 or to be enduring?

Perceived influence. This is the dimension Rosemary Knight has already talked about today, covering--as the name suggests--the extent to which parents feel they have an impact on the development of various behaviours or skills.

Perceived importance. This refers primarily to the importance attached to various goals. To take an example from Gavin Seagrim's material, the current middle class has a firm belief in the benefits of increased rationality. It also has the conviction that the route to rationality and improved thought lies in more and more schooling. Such beliefs may fly in the face of evidence but they are certainly both widespread and entrenched. Not everyone shares the belief, Gavin may be glad to hear. Margaret Mead, for example, attributed part of her intellectual success to the fact that she was "schooled" at home until about the age of 9.

2. Who holds what ideas? Historical accounts often make it appear as if certain ideas were common to all segments of the population. In fact, however, what we are usually working from are the written or recorded views of the middle and upper classes, most often male, and most often with a particular role towards children: charged, for example, with the task of educating children, saving them from hell-fire, or seeing that they did not become burdens on the state. One would hope--in the contemporary accounts-- to give more attention to asking about variations in ideas, both among the "mainstream" and among the "dissidents". That is part of the reason for our interest in comparing mothers with fathers, or members of one ethnic group with another. With luck, we shall begin to look at some aspects of the distribution of ideas about children: separating, for instance, those ideas held in common by most parents of today from those where variations occur. I am also hopeful that a current study at Macquarie of parents involved in a progressive school will yield some account of a "dissident" set of opinions (research by Andrew Reiner).

Such diversification applies as well to the children thought about. Not all children, it is clear, are thought of as having the same qualities, needs or futures. We separate the more from the less able, the deserving' from the undeserving, the privileged from the disadvantaged, the "silk purses" from the "pig's ears", the "hewers of wood" from the "lilies of the field". We have come at Macquarie to focus on whether the child discussed is male or female. That may be a less dramatic form of difference than some others I have mentioned. It is nicely within-the-family however. And it is a dimension that for centuries has yielded differences in ideas about both probable nature and appropriate nuture.

3. *What conditions bring about changes or variations in ideas?* Kessen (1979), for example, relates what he describes as "the sentimentalisation of children" to an increasing division between work and home, an increasing allocation of men to "work" and women to "home", and an increasing set of contrasts drawn between the nature of man (aggressive, powerful, sinful--often happily so--and uncultured) and the nature of women (pure, spiritual, passive, the carriers of culture etc.). His chain is complete once children come to have an increasingly total assignment to the female world of home, hearth, and heaven. "Heaven lies about us in our infancy" is Kessen's quotation from Wordsworth to illustrate this part of the chain.

Once, again, such hypotheses make marvellous reading. And they give a big picture that suggests a way of accounting for some of the ideas we ourselves hold. Once again, however, we would wish to add some sharper data on the basis of changes.

Our first step has been to distinguish among hypotheses as to how change takes place. All told, the literature yields three types of hypothesis about sources:

.. *Demand* (or ("virtue out of necessity"). Hess reports, for example, that teachers of half-day preschools have a more relaxed "timetable" than do mothers or teachers of full-day preschools (Personal communication).

.. Availability in a culture, either in the form of literature or of live models. This is the variable that Whiting for example, stresses in her study of modernisation among the Ngeca in Kenya (Personal communication).

.. Experience with children; this type of variable, as Rosemary Knight pointed out this morning, has been argued for by Stolz (1967). It is intuitively appealing and is most clearly expressed in projects at Macquarie that compare parents with little vs. more experience with children. Rosemary Knight, for example, has described for you a comparison of parents with the oldest child aged 4, 7, and 10. My sample of "Australian" and "Lebanese" keeps constant the age of the child being discussed: they are all about to start school. What varies is whether the child being discussed is the first child in the family to start school, the first to move from "apron strings to ABC's" (Kaestle & Vinovskis, 1978).

4. *What impact is there from ideas about children?* Once again, Let me start from Kessen's (1979) historical analysis. He draws out two areas of impact: the area of social policy and the area of developmental research. In both cases, he argues, we show the unhappy consequences of speaking of "the child", of regarding the child as a "self contained unit". In the area of social policy, we have come to take a "salvationist" view of the child, developing intervention policies towards children alone, ignoring the family setting or the larger community.

For developmental psychology, in Kessen's view, the result is a developmental psychology with a particular style of research. The child is almost a sealed container: "impluses are in the child; traits are in the child; thoughts are in the child" (p. 819). Given such a concept, we proceed to believe that "the proper unit for developmental analysis is the child alone" (p. 819). We work, most of the time, with one child alone. We concentrate on "those parts of development that the child could readily transport to the laboratory" (p. 819). And we pay little attention to the social situation obtaining between experimenter and child.

Once again, the analysis is provocative. But it is always inferential and based upon the relative coincidence in time of trends that appear similar.

What else could we do? As one step, we could look at relationships between parents' ideas and parents' actions. I personally am slow to take on that problem. You will find a concern with it however, in Graeme Russell's work on relationships between parents' ideas about sex roles and their divisions of labour in child-rearing. You will also find it in work currently being done by Alan and Graeme Russell. And you will find one particular aspect of it in the cross-generation work of Judith Cashmore. She has been especially interested in the perceptions of both parents and adolescents, asking how far they agree and how accurately the 12-year-olds can predict what their parents would say when asked questions about what they want for their children or what they consider their children need. Her work has the particular advantage of containing children who attend the same school, but whose parents are of different ethnic and socio-economic backgrounds. In effect, she can begin to ask whether the children reflect the parents' differences in ideas, or have moved towards being like one another.

I do not wish to suggest that tracing out the impact of ideas is likely to be easy. Ideally, one would hope to complete the links in a chain that joins with bidirectional arrows parents' beliefs, parents' behaviours, children's beliefs, and children's behaviours. Ideally also, we would hope to work out some form of path analysis. I have in mind, for example, the kind of analysis Jacqueline Parsons is carrying out at the University of Michigan, combining parents' expectations about achievement in mathematics, parents' reports of their involvement and encouragement, students' expectations, students' reports of success with mathematics, and students' choice of mathematics as an elective in high school. Parents' expectations, I am sorry to report, have more to do with the sex of the student than with any other factor.

5. *How is one idea about children related to another?* Ideas about children might be compartmentalised or coherent. In the interests of children, for instance, one might hope that ideas about the value of learning by discovery would be accompanied by a tolerance for error or, better still, by the value of teaching strategies for recovery from error. The description of historical concepts seems to stress the presence of coherence: we have, in a sense, *the* 19th century concept of *the* child. But whether such coherence occurs in fact (or the form it takes) is difficult to tell from historical data alone.

We are currently analysing data to determine whether the timetables of mothers are correlated with their ideas about the stability of behaviour. From visual inspection, for instance, it appears that mothers who expect many behaviours to appear "late" (in terms of a group "norm" are also likely to expect more behaviours to change between the ages of

6 and 12 years. If that holds up, it could make good sense: the child, in a global sort of fashion, may be regarded as relatively "unformed", still a "baby" in the double sense of being both somewhat incompetent and highly open to influence. I am not sure that is the way things will work out. I cite it, however, as an example of a question that seems seldom to be asked in the burgeoning literature on concepts about children--namely the degree to which one concept can be predicted from another.

Overall comment

I have walked quickly through the Macquarie work and its background. That is partly because I have written fairly recently two papers on background (Goodnow, 1980; Goodnow, in press), partly because most of the data is just now coming into the stage of being reportable in any precise form (questions to parents take a lot of shaking-down), and partly because I wanted to step outside my own immediate interests and mention to you some other kinds of work attempting to bring together "social" and "cognitive" aspects of behaviour.

Some further aspects of social/cognitive combinations

I shall consider several of these in relatively brief fashion. Even in their brevity, however, they give a sense of what many developmentalists are currently working on, and of the problems they see in what others are doing.

"Social cognition". Several books are about to appear under that label. I know, for example, of one being edited by John Flavell, one by Michael Lamb, and one by Joseph Forgas at the University of New South Wales.

The area, in Flavell's broad definition, covers judgments and knowledge related to people: their thoughts, feelings, personalities, memory capacities, or intentions (Flavell, 1977). The "people" involved may be either oneself or others. The contrast drawn is between "social cognition" and "physical cognition". The latter covers judgments and knowledge about objects and includes, for example, that vast range of material on children's judgments about time, weight, number, density, area, volume, length etc.

The underlying expectation is that judgments about the social world might follow a different developmental path or have a different quality from judgments about the physical world. Let me give some examples. The social world, for instance, may be more salient, attracting earlier and greater attention. People may elicit more judgments of intentionality than objects do (Chandler, 1976). People may also provide a different quality of interaction from what objects do. Interacting with objects--a toy, for instance--places demands on the child's skill: the number of things a toy can do, in effect, depends on what the child brings to the interaction. In contrast, interacting with people may require less skill; people put more into the interaction, and may in fact provide a "scaffolding" that enables children to move more easily on to a new form of behaviour (Bruner,1977). Finally, with people we may be even more tempted than usual to ignore many details and to fall back on our usual categories or "scripts" (Glick, 1978).

Work on social cognition is of major importance and a much needed addition to earlier cognitive studies. Not everyone, however, is happy with the social/physical distinction. It serves the useful purpose of drawing attention to a bias in the stimuli we have used in exploring cognitive development. There is the obvious danger, however, that people will simply repeat all the earlier studies with objects or physical properties, substituting people as stimuli with little rationale other than asking whether the same results hold with "social" stimuli. And there is--related to the question of rationale--the serious question of whether a social/physical distinction is the most useful one we can make. Some pscyhologists, in fact, already find it too gross. To take two particular objections, Reeder and Brewer (1978) point out that judgments about ability and judgments about friendliness may display different attributional patterns, even though both refer to the qualities of people. And Turiel (in press) has argued that our attitudes towards evidence vary considerably depending on whether we define a social action--abortion, for instance--as a matter of choice or custom, or a matter of morality and principle.

Such reservations suggest that we might do well to think carefully about what is to be covered by the term "social cognition". It may well be, as Turiel argues, that we would make more progress if we worked from the notion of "domains" or "categories", dividing the targets of thought in terms of some explicit rationale or in terms of observed differences in the way thinking proceeded. On that basis, we might well end by putting some "physical" targets of thought into the same category as some "social" targets.

Is there some other way of varying what we ask people to think about, outside the social/physical dimension? An interesting contender is the study of "events".

Studying "events"

Several terms are current as ways of describing the way people organise social "events", "frames", "scripts", "scenarios". The general intention, however, is one of drawing attention to the fact that, especially for repeated events, we develop expectations about the way events will unfold, expectations that have a pattern to them. "Going to eat in a restaurant", for example, is a repeated event for which we are said to develop scripts that contain "props" (objects or people) and that may be divided into "episodes" or "scenes" that should follow a particular order and that are of varying importance. You may or may not be seated by a hostess, for example, but you should eat and someone almost always pays for the meal.

"Scripts" have attracted considerable attention in the U.S. (I understand the term of equivalent interest in the U.K. is "scenario"). I find them of interest partly because they are a novel form of categorisation: a departure from studies of the way we classify objects or shapes or people. I am also attracted to two suggestions by Katherine Nelson. One is that categories of events --"eating", "playing", "sleeping"-- may be among the earliest categories children develop. The other is that scripts may give us a way of asking about the nature of "pretending". When children act out a "pretend" script", for example, what parts of the action become exaggerated, excluded, or possibly placed in a new order? (Nelson, 1978, 1979).

Discussion about scripts has tended to out run ways of studying them. Part of the gap is being filled by Forgas (1980). He is particularly interested in the way people group "episodes" ("shopping", "watching TV", "going to the football", "going to a sherry party" etc). To isolate groupings and dimensions he relies predominantly on multidimensional scaling. That approach, however, is not directed explicitly towards people's ideas about how events unfold. For that gap, we now have some of the picture filled in by the experiments carried out by Bower, Black, and Turner (1979), and by Nelson (1978, 1979). But not everyone is happy with those studies, either. They rely exclusively on people reporting verbally all the things they do when they go through a familiar set of actions such as "going to the doctor" or "having lunch at the day care centre". The only contrasting approach appears to be that of Darren Newtson (1976), brought to my attention by Alan Hayes. Newtson's technique is one of asking people to mark the beginnings and ends of filmed events, and then analysing the nature of the "breakpoints".

Why would there be, however, any reservation about relying on verbal reports? I raise that question because it is at the moment part of a running debate. One that appears almost in the form of Letters-to-the-Editor of the Psychological Review. It does appear that verbal reports are more prominent than they were, say, 10 to 15 years ago. Subjects are asked to describe their memory processes. They comment on the language they use. And they "think out loud" as a way of indicating the nature of decision processes.

Now all this use of verbal reports has not gone unchallenged. In the current debate, Nisbett and Wilson (1977) cast the first stone, arguing that subjects' reports of the way they made judgments often did not correspond with patterns of success or error. Eliot Smith (Smith and Miller, 1978) replied from California, White (1980) from Oxford, and Carnegie-Mellon, I am told, is about to join in. Minnesota may well be next. This winter, for instance, John Cavanagh and Marion Perlmutter were hard at work on the draft of a paper asking whether work on "metamemory" had in fact succeeded in avoiding the dangers and errors of earlier "introspectionism". Moreover, to my great surprise, I heard at Minnesota--Flavell's earlier strong base--the work on metacognition described as concerned with an "epiphenomenon".

Much of this debate strikes me as arrid. It becomes more interesting when people get down to asking when verbal reports might be more or less in line with motor actions (Smith & Miller, 1978; White, 1980), or why some of us are more comfortable with the response of pressing a key than with the statement of "yes" or "no". I bring it to your attention today because it seems likely to cloud the study of phenomena that I regard as interesting; the study of awareness, and the study of events.

Using "meaningful" stimuli or "meaningful" contexts

Part of the concern with the child's social world takes the form of an interest in what happens when children work with material that is of intrinsic interest to them, or that is embedded in a context of interest to them. Let me give three examples. One is Doloache's current work on children's performance on perceptual tasks when the object to be watched or searched for is one that catches attention: the figure of Big Bird from Sesame Street, for example. The other is a renewed interest in

Istomina's study of kindergarteners' memory for items when these are simply recalled as a list as against being part of the task of going to the store (cf. Brown, 1978). The third is Gelman's (1979) comment that she has undervalued the numerical skills of children because she tended to look for them always in "experimental" rather than "natural" contexts.

Those three examples are part of a far more widespread concern with the role of context or situation on performance. I shall limit my comments to some questions that still need to be solved.

The first of these is as follows: What is the precise effect of changing a stimulus or a context? It is easy, for example, to say that one stimulus is more "meaningful" or more "ecologically valid" than another, but that may not take us very far. I have in mind, as a contrast, Ann Brown's (1978) suggestion that the reason Istomina's change in context makes a difference is that the goal of the task is more salient in the shopping context. That at least is a step towards specifying the difference between one context and another.

The second question concerns relationships between context effects and what we call "development". The question is really double-barrelled. One part of it comes up in Gelman's (1979) proposal that the difference between a four-year-old and and eight-year-old on number tasks is that the performance of the four-year-old is more "fragile". It appears in some situations, with some stimuli. In contrast, the eight-year-old's performance is sturdier. It appears in a wider range of appropriate situations and can be elicited with fragmentary stimuli or in the face of distraction or, as in many Piagetian tasks, in the face of temptation toward error. If we go this route, however--as John Taplin has remarked to me--then what we shall need to do is to become very explicit about the criteria of performance we use in any argument about whether a particular ability is or is not present at a particular age.

The other barrel to the question of context and development is the possibility that development might be equated with "decontextualisation". The ultimate goal of development might be thought of as the ready conversion of any specific problem into an abstract form--p's and q's, or numbers. That view of ultimate development seems to be implied in some studies of formal reasoning, and in the notion of "disembedding" proposed by Donaldson (1978) and discussed yesterday by Chris Pratt. Conversion to a "decontextualised" form, however, is not what we readily do, to judge from studies of adult reasoning. There are in fact some arguments that such an approach may have low "survival value" (Hunt, 1974). It is slow and lacks the built-in check upon error that comes with the problem in concrete form (we check the answer against what we know it should be) (Hunt, 1974). It may even run counter to what Whitehead has argued is the goal of civilisation, namely a constant "extending (of) the number of operations which we can perform without thinking of them" (Langer, 1978).

Studying more than one child at a time

Kessen would like to see us break away from the tradition of studying "the child alone", of observing a child--to use a comment from Jerry Bruner--"locked in solitary battle with the stimulus material".

One way of breaking from that tradition is to study more than one child at a time. Let me give you two examples. One is some current work by Michael Cole, analysing the way pairs of children work together in a cooking club. Very often, he has commented, the children divide up the work. One child does the actual sifting and cooking. The other runs interference, looking ahead to see what is needed, protecting the critical gadgets (sifters etc.) from the other pairs. That kind of behaviour, Cole argues, is not likely to be observed in a solitary situation. Of even more interest to me is his comment that children with "learning disabilities" of various kinds need to be observed in groups. The one such child in the club took a long time for them to detect--in fact, their attention had to be drawn to him. What the child had developed was a set of strategies that avoided areas of weakness and made maximal use of others as resources. Cole's comments on the cooking club in general are still to appear. His report on "Archie" will appear in the next volume of the Minnesota symposia.

Of equal interest to me is the work of Doise (1978) in Geneva. That has already appeared in print and is well worth reading. I shall choose two tasks to illustrate his work. In one, he uses the classic "Three Mountains" test from Piaget to compare the performance of a child alone with the performance of that child when a group works together. I shall quote his conclusions (p. 82):

> . . .social interaction leads in certain conditions to more complex structures than individual action . . . cognitive norms which develop in a social interaction situation are readily accepted by the individual and are likely to be applied again in situations where there is no interaction between pairs". . . .

The second kind of task is concerned with the qualities children attribute to one another. The children may be asked to describe people in photographs or to check adjectives on a check list for the extent to which they apply to "boys" and to "girls"; adjectives such as submissive, clumsy, reasonable, abrupt, self-assured (p. 170). What varies is the composition of the group present when the descriptions or ratings are carried out, and the history of any competitive interactions built into the experimental setting. I shall limit myself to one finding only. Two subjects of the same sex "will evaluate less favourably the representatives of the other sex than one subject alone" (p. 200). To become less stereotyped in our views of the opposite sex, Doise suggests, we had better first break up the solid phalanx of each sex working, playing, or talking only with members of its own group.

Now studying more than "the child alone" is clearly not the only way in which we can get at combinations of "social" and "cognitive" variables. Why single out this particular kind of approach?

I do so because this kind of experimental variation tends to be accompanied by some theory. Doise (1978) would like to consider a change from two earlier ways of looking at social and cognitive behaviour. In one, cognitive development precedes changes in social behaviour. Adelson, Green and O'Neil (1969) is an example, proposing that the development of formal thought precedes the development of ideology. In the other view, "social" and "cognitive" understanding are two sides of the same coin. That is, I think, the Piagetian view, paralleling the argument that language and thought express the same logical structures. Doise (1978) proposes a third possibility: "behaviour, evaluation, and representations of individuals (may) depend on social relations" (p. 209).

The theory Cole relies on is Vygotsky's. In particular, Cole has adopted Vygotsky's concept of a "zone of proximal development", defined as,

> . . . the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. . . .
>
> (Vygotsky, 1978, p. 86)

It is this "zone of proximal development", Vygotsky argues, that we should be trying to determine in any testing of children. And it is this "zone" we should be aiming at in organising instruction. Finally, it is the study of this "zone" that brings out the three ways by which Vygotsky sees "culture" as influencing thought: arranging for various problem solving environments to occur at all, regulating their frequency, and regulating their difficulty so that they focus on and narrow down the "proximal zone". If I were asked to choose two examples of a shift towards a more and more frequent combining of "social" and "cognitive" variables, they might well be a return of interest to the more "social" tasks considered by Piaget, and a rise of interest in the theory of Vygotsky. Either way, what is extraordinarily clear cut in current work on "cognition" is the pervasive insistence on considering the "social" context or setting within which it occurs.

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PARENTS' BELIEFS ABOUT COGNITIVE DEVELOPMENT: THE ROLE OF EXPERIENCE

Rosemary Knight
Macquarie University

How far do parents' ideas about cognitive development vary with conditions such as education or the experience of parenting? This question sits at the junction of two lines of interest: one concerned with cognitive-mediational approaches to parenting, the other with adult cognitive development.

A mediating role for parents' beliefs has been argued for by several investigators (Block, 1976; Emmerich, 1969; Goodnow, 1980; Hess & Kashigawi, Note 1; Parke, 1977; Sameroff, Note. 2). The common argument is that it is difficult to understand parent-child interactions unless we know more about the meanings of interpretations parents give to a child's overt behaviours; more, for example, about implicit time-tables, beliefs about ideal methods of teaching, attributions of responsibility for growth or for lack of progress. The area contains more expression of interest than it does data. The data needed falls into three broad areas: the contents of beliefs, the way these are related to overt behaviour, and the conditions that affect beliefs. The present study is concerned with the third of these areas, with a stress on ideas about the development of ability. Parents may often be described as "educators" (e.g., Schaefer, 1972) but their beliefs about any teaching role are relatively unknown.

The second line of interest is the nature of cognitive change in adulthood, between adolescence and old age. Most studies have been concerned with psychometric or information-processing measures. We wish to follow instead a suggestion by Flavell that the greatest area of change may "have to do with judgments, attitudes, and beliefs": An area that is superficially "social" but that "most decidedly entails genuine cognitive activity" (Flavell, 1970, p. 250). The correlates of change may then be not age per se but the experiences adults encounter: "marriage child-rearing, occupational-activities, grandparenthood, retirement, widowhood, and so on" (Flavell, 1970, p. 250). As an example, Flavell (1970) cites Stolz's (1967) study of difference between mothers and fathers in ideas about child-rearing. Variations, Stolz argued, should occur as a result of differential interactions with children, leading to different experiences with the success and failure of particular methods. Such an argument for differences between parents would certainly fit well with the current emphasis on sampling both mothers and fathers in any study of parents (e.g., Lamb, 1979).

In the present study, the effect of experience is explored by comparing (a) mothers with fathers, and (b) parents of preschool children with parents of older children. The more conventional correlates of beliefs are represented by (c) variations in education.

Ninety-four parents (47 couples) were interviewed at their home. Parents were interviewed separately, by the author. The interview consisted of 20 open-ended questions. Some of these dealt with parents' goals and with ideas about the nature of ability (e.g., what skills parents wanted their child to have; whether abilities displayed in childhood could be lost in adulthood, or new ones gained). Some dealt with perceived determinants of skill (e.g., the role of effort and luck in ability and success; the strength of parents' influence over their child's skills; whether abilities were mainly inherited or acquired). Others dealt with the relative role of home and school (e.g., the extent of perceived overlap in responsibility and influence). Finally, a small set dealt with ways of assessing skills (e.g., the techniques used to monitor a child's progress at school).

Parents were recruited from four suburban shopping centres, chosen to give a variation in socio-economic status. Varying the time of the day, and the time of the week, men and women were asked if they would consent to being interviewed at a date and time convenient to them. Three criteria were set for inclusion in the sample; to be from a two parent family; have a child under 10-years-old; and be able to speak English. (The city from which the sample was drawn contains a fair proportion of recent immigrants from non English-speaking countries.)

Parental statements were coded and related to three variables: educational level, sex of parent, and age of child.

In education, the primary division was between those who had completed high school (fathers 43%, mothers 40%) and those who had not. A sizeable proportion had no further training (fathers 32%, mothers 45%), making the end of high school the most effective division. As a correlate, education was preferred to an index such as Hollingshead's (Note 3) because few of the mothers (23%) were employed either full or part-time. The index would have to be based on education and occupation of the fathers only.

Education affected two questions, both related to schooling. On one, "What do you think is the job of the school?", the group with more education was less likely to give the undifferentiated answer of "education" and more likely to stress "curiosity". Statements were coded as concerned with "education", "the three R's", "academic skills", e.g., science, "practical knowledge", "stimulation and curiosity", and "personality attributes". The distribution of answers for the better-educated group was 13%, 36%, 10%, 0%, 26% and 15%. For the group with fewer years of schooling, the distribution was 41%, 33%, 4%, 7%, 9% and 6% ($\chi^2_5 = 16.5$, $p = .005$).

The second question asked "How would you or do you tell if your child is doing well at school?" Two categories accounted for the difference. Answers were coded as "judge from the child's mood and happiness (38% vs. 12%), "observe specific performances", e.g., homework (5% vs. 33%), "use others' judgments", e.g., teachers' reports (38% vs. 36%), "ask the child" (15% vs. 15%) and "no specific technique" (3% vs. 4%) ($\chi^2_4 = 15.2$, $p = .004$).

Mothers and fathers displayed largely traditional divisions of labour (few mothers employed). Nonetheless, only one question yielded a significant difference. This dealt with the perceived overlap between home and school. Answers coded as "total overlap", "some overlap" and "no overlap" were given by 7%, 69%, and 24% of fathers as against 23%, 49%, and 28% of mothers ($\chi^2 = 5.7$, $p = .06$). In this community, most contact with schools would be carried out by mothers. The division of labour, however, has no obvious relationship to the difference in parents' statements.

The lack of difference between parents was surprising. It suggests the need to consider carefully any routine sampling of both parents, asking instead what areas of belief or behaviour are most likely to vary between the two; a question posed especially by Block (1976). At the moment, we are in the anomalous position of there being some studies that report a clear difference between mothers' and fathers' beliefs about development (e.g., Russell, Note 4; Stolz, 1967) while others report little or no difference (e.g., the present study; Clarke-Stewart, 1978; Emmerich, 1969). It is far from clear whether such variations stem from differences in the characteristics of parents (e.g., personality, sex-roles, involvement with children) or from differences in the domain of behaviour (e.g., cognitive vs. social development).

The variable with an unexpectedly strong effect was the *age of the child*. Forty-nine percent of the families had no child as yet in school. The remaining 51% had at least one child in school. In both groups, however, the parents were relatively "young". The mean age of the oldest child was 6.1 (SD 4.1). The mean number of children was 2. The mean age of parents was 33 (SD 5.9) (mean for fathers 34, for mothers 31 years). And mean parental age was not markedly different between the two groups (Group 1: fathers 31, mothers 28 years; Group 2: fathers 37, mothers 34 years).

Four questions yielded a significant difference. In general, the differences display a shift from a stress on environmental factors (including parental influence) to a stress on factors within the child (covering both heredity and the child's own effort).

Two questions yielded answers coded as (a) "mainly environment", (b) "an interaction", and (c) "mainly heredity", "Do you think children who are bright are basically born bright or can a child be taught to be clever?": "What is it about parents that makes a difference to how bright a child is?" To the first question, answers coded (a), (b), and (c) were given by 40%, 24% and 36% of parents in Group 1, vs. 13%, 17% and 70% of parents in Group 2; ($\chi^2_2 = 11.8$, $p = .002$). For the second question the division was 81%, 19% and 0% vs. 39%, 42% and 19%, ($\chi^2_2 = 12.9$, $p = .002$)

In similar fashion, parents of preschoolers were more likely to give positive answers when asked: "How much influence do you think you have over what your child is good at?" Answers coded as (a) "quite a lot", (b) "in some ways/areas", (c) "very little", and (d) "don't know" were given by 62%, 29%, 2% and 7% of the first group of parents, vs. 37%, 25%, 17% and 21% of the second group ($\chi^2_2 = 11.3$, $p = .01$).

The fourth question yielding a difference asked: "How important do you think effort is in doing well?" Answers coded as (a) "very important", (b) "moderately important", and (c) "not very important" were given by 35%, 61% and 4% of parents in Group 1 compared with 60%, 40% and 0% of parents in Group 2 ($\chi^2_2 = 7.4$, $p = .02$).

The impact of the child's age could be mediated by several factors: the age of the parents, the sheer length of parenting, or the change in interactional patterns as the child moves outside the parents' orbit. The last of these seems the most important. To judge from statements, parents of preschoolers feel they are at the peak of their influence and power. Once children are in school, parents share prestige and decision-making with a new group of "significant others". In the words of one parent, "Once they're in school, they don't seem to hear your voice in the same way". Parents are also now faced with direct comparisons between the skills of their child and those of others. The overall effect seems to be a turning towards a different attribution pattern for development, stressing factors outside the parental role: In the present study, heredity and the child's effort. If this analysis is correct, then the variables worth further work in parents' beliefs are those concerned with the influence and power of parents, both the domain of influence and the way influence waxes and wanes over the course of the parents' and the child's life cycle.

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THE DEVELOPMENT OF THE CONCEPT OF DEATH IN CHILDHOOD

Jyotsna Field and John E. Taplin
The University of New South Wales

What does a child understand about the nature of death and its causes? The answer to this question is likely to have important practical implications concerning, for example, the type of care provided for a child who is suffering from a terminal illness or who has been bereaved. Despite this, surprisingly little empirical research has been done to determine the nature of the child's concept of death or to discover how it develops. Indeed, the actual number of published studies on this question during the past 50 years does not even reach double figures, although the psychoanalytic literature does also contain several reports of children's reactions to death and dying seen from a rather different perspective (e.g., Maurer, 1961).

One of the first suggestions concerning the development of a concept of death in the child comes from Piaget (1926, 1929). He proposed in a study of the kinds of questions asked and explanations provided by young children of various natural phenomena that there is a relationship between their understanding of death and its opposite concept, life, and their concept of causality generally. The same hypothesis was put forward but not tested by Sylvia Anthony (1940) following her pioneering survey of the views of children between the ages of 5 and 12 years, about death. A comparatively recent study by Bernstein and Cowan (1975) has confirmed that the child's developing concept of the origin of human life does parallel yet lag behind the development of his concept of physical causality, but so far, to our knowledge, there has been no direct examination of the relationship between the concept of causality and the concept of the cessation of life, or death.

One thing which has been quite clearly established by previous research is that there is a close relationship between the concept of life and death assumed by a child and his level of cognitive development as measured by conventional Piagetian tests such as conservation and hypothesis testing. Bernstein and Cowan (1979) demonstrated this, for example, in their investigation of the child's understanding of how people get babies, while Koocher (1973) obtained a similar finding in a study of the child's concept of death as measured by responses to the following four questions: "What makes things die? How can you make dead things come back to life? When will you die? and What will happen then?"

It is important to note the methodology employed in research so far to measure the concept of death in the child. Early investigators, for example, tended to rely on answers to open-ended questions and uncontrolled associations produced in response to a word such as "death"; these might be expressed in the form of written compositions (e.g., Anthony, 1940; Nagy, 1948) or drawings (Nagy, 1948). More recently, researchers have preferred to ask a limited number of standardised questions of the child to which the range of alternative answers available is more restricted. The study by Koocher (1973) illustrates this latter approach. Unfortunately, it also illustrates the need to use questions which have been more carefully worded so as not to presume or suggest to the child a particular type of answer. For example, the question "How can you make dead things come back to life?" presupposes that the answer to the question "Can you make dead things come back to life?", if it had been asked, would have been "yes" for all children. Likewise, the question "When will you die?" presupposes that an affirmative response would be given by all children to the question "Will you die?" Studies by Childers and Wimmer (1971), Melear (1973) and White, Elsom and Prawat (1978) all fail to support the presumption implicit in these questions employed by Koocher although they are not in complete agreement themselves as to what the precise relationship with age should be in each case.

Measurement of the concept

The first aim of the present study thus was to examine ways of measuring what the child knows about death. In fact we looked at four different measures to see whether there was convergence between these measures or divergence, that is, to see whether the concept of death in the child is a unidimensional concept or a multidimensional one. The' four measures were concerned with the cause of death, the question of whether death is reversible, the question of whether death is inevitable and universal, and the appearance or characteristics of death compared with life.

Cause of death was assessed by the following two questions: "How is it that people and animals die?" and "What happens when you die?" Responses to these questions were scored using the Nass (1956) revision of Piaget's original categories of causal thinking. Thus four main categories of response were identified:

1. Noncausal--responses pointing to complete incomprehension, including answers such as "I don't know";
2. Precausal non-naturalistic--animistic, artificialistic, dynamistic, finalistic, etc. responses;
3. Precausal phenomenistic--responses linking death with some event or condition without clearly indicating causal connection, e.g., "old age", "illness", "car accident", etc;
4. Naturalistic--responses showing recognition of cessation of bodily functions, e.g., "heart stops beating and can't be started again", "stops breathing".

Two independent judges scored the responses of each child in this way and the interrater reliability coefficient was 0.91.

Reversibility of death was assessed by a single question: "Can you make dead things come back to life?" If the answer provided by the child to this question was "yes", it was followed up by the question: "How can you make dead things come back to life?"

Inevitability of death was assessed by two questions: "Do you think you will ever die? When?" and "Can you avoid dying?" An awareness of the inevitability of death was indicated by a response of "yes" to the first question and "no" to the second.

The child's knowledge of the appearance of death compared with life was assessed by presenting each child with five pairs of photographs, one member of each pair depicting a live animal and the other a dead animal of the same species. For each pair of photographs, the child was asked to say which animal was alive and which was dead and then to indicate which features in the photographs helped them to tell the difference between dead and alive. A quantitative index of the number of attributes mentioned was thus obtained, using the following feature categories as a basis for scoring--movement, expression (e.g., eyes closed), bodily posture, other bodily signs, behavioural cues, environmental cues, and causality (e.g., it's been run over).

The concept of death was thus measured in these four different ways in a sample of 75 children made up of 25 children in the age range 5-6 years ($\overline{X}$ = 5;7), 25 children aged 7-8 years ($\overline{X}$ = 7;10), and 25 children between 11 and 12 years ($\overline{X}$ = 11;11). There were approximately equal numbers of each sex in each age group. All children were drawn from the same school (a state school, not a private, church-sponsored school), and could speak English fluently. Any child with direct experience of parental death or parental separation or divorce was excluded from the study. However, children with experience of the death of a relative or pet were retained, and this variable was later examined for its relationship to the death concept held by the child.

Table 1
Inter-correlation Matrix Between Measures of Death Concept Based on 75 Children

	Causality	Reversibility	Inevitability	Distinguishing Features
Causality	-	.093	.054	.246
Reversibility		-	.021	.194
Inevitability			-	.436
Distinguishing features				-

The first question to be answered then is: Are the four measures of the child's concept of death highly correlated with one another and thus based on the same underlying dimension of understanding, or are they to some extent uncorrelated and thus measuring different dimensions of the meaning of this concept? The matrix of correlations between the different measures is shown in Table 1 and conveys the suggestion that the concept of death is not a unitary one, that at least two separate components to the meaning of this concept may be involved. Specifically, the child's understanding of the cause of death is seen to be only weakly related to his identification from the photographs of the characteristics that distinguish dead things from living things. Awareness of the inevitability of death correlates significantly with scores on both of these tests, while the reversibility measure is associated with neither.

There is reason to have some doubts about the validity of the measure of reversibility. This is because an examination of the answers to the follow-up question "How can you make dead things come back to life?" revealed some important qualitative differences among those who had responded affirmatively to the first question. These differences, moreover, were linked with age and explain the otherwise curious trend whereby the proportion of children accepting the proposition that death is reversible first decreases with increasing age and then increases again. Thus, children in the oldest age group who said "yes" to the reversibility question almost invariably referred to the possibility of restarting the heart beating or restoring breathing by mouth-to-mouth resuscitation. Children in the youngest age group, on the other hand, produced answers which were less easy to classify but generally involved a reference to some outside agent such as an ambulance or a doctor. Given these different explanations of reversibility, it is oversimplifying the measure to score them in the same way. As a consequence, the absence of any correlation between this measure and causality of death should be regarded with suspicion. Very likely too, this oversimplification in the scoring is the reason why previous investigations of the reversibility of death questions have yielded conflicting results concerning the relationship between judgments about it and developmental age (see, for example, Childers & Wimmer, 1971; White et al., 1978).

Relationship with indices of development

It seems reasonable to say then that there may be two primary dimensions to the concept of death whose development one ought to study--knowledge about cause and knowledge about the distinguishing features of death. The next question was asked: How do these two types of knowledge vary with the age of the child? An analysis of variance using planned contrasts showed that, for both causality and distinguishing features, there was a significant difference between the 5-6-year-olds and the two older groups ($F(1,72) = 5.869$, $p < .05$, and $F(1,72) = 43.577$, $p < .001$ respectively, but only the distinguishing features measure showed any difference between the 7-8-year-olds and 11-12-year-olds, $F(1,72) = 33.882$, $p < .001$.

Of course, the effect of age on the development of a concept such as death may be mediated in several ways. One may be as a result of specific learning, say, through direct experience with either a person or animal that has died; in the present study such experience was found to increase with age. The interpretation and understanding of such experiences, however, may also depend on the level of cognitive development attained by the child. This relationship with cognitive development as measured by scores received on a test of conservation is perhaps the clearest finding arising out of past research. Thus, it seemed important to replicate this effect of level of cognitive development in this study and further to see whether it was evident equally on both dimensions of the concept which we have identified.

For this purpose, all children were given two tests of conservation, one for mass and one for volume. These two tests had been previously used by Bernstein and Cowan (1975) in their study of children's concepts of how people get babies, and we administered and scored responses on each task in the same manner as followed by those authors. Both judgments and explanations of judgments were taken account of in the scoring procedure and the resulting conservation test scores obtained by two independent judges showed a reliability coefficient of 0.97. This score showed a significant difference between the 5-6-year-olds and the two older groups $F(1,72) = 5.869$, $p < .05$, but there was no difference between 7-8-year-olds and 11-12-year-olds on this test.

In addition to this conservation test score, a second measure also presumably linked to the child's level of cognitive development was obtained. This was the child's concept of physical causality as indicated by a test of his/her understanding of the origin of night. An adapted version of Laurendeau and Pinard's (1962) questionnaire was used for this purpose, but in scoring responses the same categories of causality were employed as were used to classify causality of death rather than the scale devised by Laurendeau and Pinard. That is, children's explanations about the origin of night were classified by two independent judges as either noncausal, precausal non-naturalistic, precausal phenomenistic, or naturalistic; the reliability coefficient between the judges in this case was 0.94. As a function of age, the results of this test showed a significant difference between the 5-6-year-olds and the two older groups, $F(1,72) = 44.916$, $p < .001$, but there was no difference between the 7-8-year-olds and the 11-12-year-olds.

Thus, two different indices of the child's level of cognitive development were obtained, one concerned with the concept of conservation, the other with physical causality. As expected, the correlation between them, although not large, was significant, $r(73) = .329$, $p = .002$. The next step was to see to what extent these two variables and also the variable indicating whether or not the child had known of the death of either a relative or family pet was related to the two primary measures of the concept of death noted previously. Two multiple regression analyses were carried out to this end. In each case, all the variables and their interactions were entered together and the effect of each one tested when the effect of the remainder was controlled. This yielded the following two equations:

$$d_1 = .476n + .197c \qquad (1)$$

where d is the measure of the death concept represented by causality; n refers to the measure of physical causality whose significance in this case was given by $F(1,67) = 14.124$, $p = .000$; c is the conservation test score, which also was found to contribute significantly to d_1 as shown by $F(1,67) = 3.242$, $p = .076$. Altogether the multiple regression on d_1 accounted for 32.2% of the total variance.

$$d_2 = .326n + .206e \qquad (2)$$

where d_2 is the measure of the death concept represented by the number of features given to distinguish dead things from living things; n is the measure of physical causality based on the origin of night, which has a significance to the regression equation given by $F(1,67) = 5.614$, $p = .021$; e is the measure of the child's experience in this study of pets or relatives who have died, where the significance of this variable controlling for the effects of n is given by $F(1,67) = 3.61$, $p = .080$. Altogether the multiple regression on d_2 accounted for 20.0% of the total variance.

Conclusions

The above results enable us to draw the following conclusions. Firstly, it is apparent that both measures of the child's concept of death are significantly related to his/her level of cognitive development. This confirms the one clear finding to emerge from past research into the concept of death during childhood, that it is significantly correlated with the child's ability to conserve. Note that the absence of a significant effect of conservation on $\underline{d}_2$ does not indicate that there is no relationship with this dimension of the concept, only that the variance it contributes to $\underline{d}_2$ over and above the effects of other variables including the causality of night, is insufficient to achieve significance; the simple correlation between conservation and $\underline{d}_2$ was $\underline{r}(73) = .225$, $\underline{p} = .026$.

Secondly, Piaget's hypothesis of more than 50 years ago that there ought to be a close association between the child's concept of death and the child's concept of physical causality has been confirmed for both measures of the concept identified in this study. To our knowledge, this represents the first empirical demonstration of the validity of this hypothesis. In this regard, it is worth noting the existence of what may be referred to as horizontal décalage between the development of an understanding of the essentially biological basis of death and the development of a concept of physical causality as exemplified by an understanding of the reasons for night. Whereas the majority of children in the study were inferred to have a phenomenistic concept of the cause of death, the modal concept of the origin of night was found to be naturalistic. A similar observation was made by Bernstein and Cowan (1975) in their investigation of the concept of the origin of human life.

Thirdly, the role of experience, albeit only weakly varying in the present study, appears to operate selectively on the two measures of the child's concept of death we have isolated. That is, it had a significant effect only on the child's knowledge of the features that differentiate living animals from dead animals and was of negligible consequence for the understanding of causality. That the absence of any effect on the latter measure was not merely concealed by the effects of other variables in the regression analysis can be seen by the size of the simple correlation, $\underline{r}(73\_ =.075$, $\underline{p} = .260)$. Of course, it is possible that this lack of any significant association with causality is due to the limited degree of experience permitted subjects in this study. As other researchers (e.g., Safier , 1964; Gartley & Bernasconi, 1967; Tallmer, Formanek & Tallmer, 1974) have commented, even when a child has had no direct acquaintance with someone who has died, some indications of what death is like and how it may occur can be seen on television where this topic receives rather more prominence than it ordinarily does in everyday life. Whether the effects of experience obtained in this study would also be found when the child has known of the death of a member of their immediate family, therefore, is a matter for further research to discover.

What does the development of the child's concept of death in these respects imply about the likely reactions of children, for example, who are faced with the problem of coping with bereavement? Presumably the emotional response of children to this circumstance is in some way a function of their understanding of how their parent no longer comes to be living with them. The precise form of this relationship, however, is unclear and thus, for this reason, is the subject of a follow-up study of bereaved children now in progress.

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PREJUDICE IN MIDDLE CHILDHOOD: AN EXPLORATORY STUDY

Shelley Phillips
University of New South Wales

The present paper reports an exploratory study of a method for looking at ethnic attitudes and prejudice in children. The method is derived from children's processes of judgment and evaluation rather than an extrapolation of adult attitudes into the mind of the child, which is an aspect of many previous questionnaires for children.

The study was thought worthwhile in view of the shortage of satisfactory measures of social attitudes in children. Attitudes of prejudice are of particular consequence in contemporary technological society, which features large scale immigrations of peoples from poor economies into highly developed countries to expand the industrial workforce. School children most of all experience the melting pot society which such massive contemporary immigration programmes entail.

The pioneer work linking attitudinal prejudice with authoritarianism and the development of questionnaires suitable for children by Frenkel-Brunswik (1948, 1953) and Gough, Harris, Martin and Edwards (1950) is acknowledged. More recently Insel and Wilson (1971) and Nias (1972, 1973) raised some problems in the investigation of children's conservative attitudes and translated an adult scale into a children's scale of social attitudes.

Method

Subjects. The sample comprised 2279 fifth and sixth grade pupils from a random sample of government, independent, and progressive primary schools, covering all inner and outer metropolitan areas of Sydney. Numbers of children from each school ranged from 33-67. Within schools subsamples in various ages were: 9 years, N = 19; 10 years, N = 723; 11 years, N = 1078; 12 years, N = 439; 13 years, N = 14. Six children gave no age. The grade subsample was fifth grade, N = 967; and sixth grade, N = 1277. One child was in the fourth grade, and 34 had no grade recorded. There were 1119 girls and 1158 boys. The sex of two children was not recorded. Fifty-seven different nationalities were represented in the sample.

The development of the LMSP

The first stage of the study consisted of free discussion about playmates with children and the collection of statements made most frequently by them about ethnic groups. These statements, taken from the children themselves, reflected cognitively concrete methods of evaluating, judging, and defining their preparedness to accept members of other ethnic groups. Consistently, degrees of intimacy, seen as desirable with members of other ethnic groups, were expressed in a descending order of demonstrable social acts as follows: (6) not to play with, (5) to play with at school, (4) to have home to play, (3) to have to tea, (2) to have to stay overnight, (1) to marry when grown up.

The expressed expectation of marriage as the best possible state to be in as an adult was common among male and female children alike. Because of the value placed on it, it was used consistently to define ultimate rejection or acceptance of other ethnic groups. This suggested an attitudinal measure appropriate to the concrete level of the thinking of the subjects. Described as the Ladder Measure of Social Proximity (LMSP) it involved the following question, together with a list of ethnic groups (put to the children by a trained psychologist) and space for comment: When you grow up would you be willing to marry any of the following persons?

	Yes	No	Give reason for your answer
Turkish			
Japanese			
Australian			
Arabic			
Dutch			
Italian			
Palestinian			
Chinese			
Aboriginal			
Jewish			
American			
French			
Spanish			
Jugoslav			
Greek			
German			
Lebanese			

The LMSP formed part of a Middle Childhood questionnaire and included prior instructions and practice examples in answering procedures and the statement: the paper before you has questions about what you think and what your interests are. The ethnic groups listed were selected on the basis of pre-tests for general familiarity and clarity for the children; they also included those who, in the interviews, had been the targets for negative attitudes by some or all children. The latter criteria excluded "common heritage" groups such as the British discussed elsewhere (Phillips, 1979b). Pretrials indicated that 17 cases were optimum for complete replies in all socio-economic and educational areas.

Pearson correlation coefficients, chi-square, and the paired sample t-test (Klecka, Nie & Hull, 1975) were used in the analysis.

Results

The hierarchy of social proximity. When asked whom they would be prepared to marry, the subjects produced evidence of a ladder or hierarchy of social proximity which can be seen in Table 1.

Table 1
Percentages of Children in the Sampe who Stated that they were Willing to Marry Members of each Ethnic Group.

Ethnic group	%	Ethnic group	%	Ethnic group	%
Australians	88.5	Spanish	23.3	Jugoslavs	13.0
Americans	66.0	Germans	23.1	Jews	12.9
French	31.5	Japanese	22.0	Turks	10.2
Dutch	27.9	Italians	18.7	Arabs	9.3
Aboriginals	23.9	Greeks	18.3	Palestinians	9.3
Chinese	23.7				

Insular responses. The most important reasons for being willing or not to marry a person from a particular ethnic group were as follows:

1. whether the person is from the child's own country;
2. whether "they are like us";
3. whether the respondent had met few or none;
4. the respondent disliked the customs of the particular ethnic group;
5. the respondent was concerned that the language was difficult; and
6. the respondent was concerned about unfamiliarity or remoteness.

These kinds of statements were defined as insular rejection based on unfamiliarity.

Prejudiced responses. Prejudice was define as the inability to see members of another ethnic group as having a variable range of behaviours and personalities. Included were, (a) negative statements such as "they are wogs", "they are greasy", or "they are oily", given by 7-8 percent of children where the testing established that the use of these terms was reliably negative (paper in preparation). Some of these were so consistently offered as reasons for not marrying as to suggest the existence of hostile stereotypes across the sample, particularly in respect of Greeks and Italians (Phillips, 1979b); (b) statements of hatred: 4½ percent of children stated they hated many of the least-favoured groups, and (c) lack of awareness of logic: 15-20 percent of children could find no reason for their rejection of particular ethnic groups.

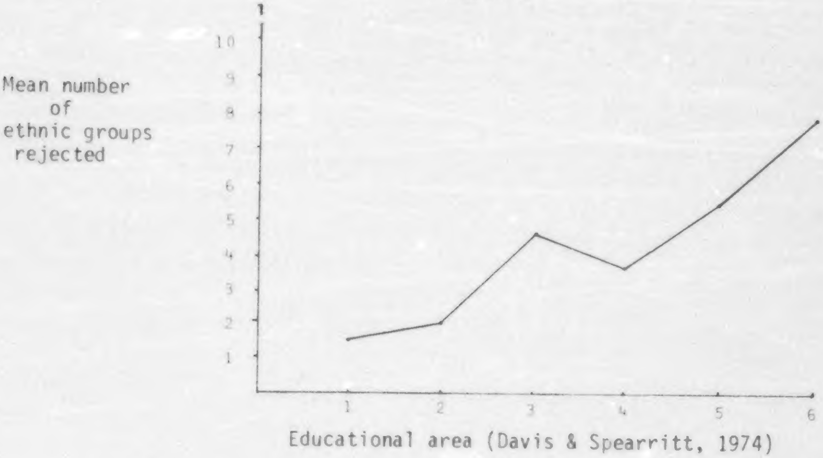
Reliability and validity

Test-retest. Five hundred and thirty children from grades 5 and 6 were given the test a second time after a six month interval. The test-retest correlations (paired sample) were .96. The time interval was unavoidable and this and maturational and learning effects could contribute to error variances. Nevertheless, the results for the test-retest reliability suggest that the attitudes sampled in the questionnaire have strong reliability over time.

Discriminative validity. The discriminative validity of the LMSP was checked by comparing scores of children in suburbs where the educational level was high with those where the educational level was low (Davis &

Spearritt, 1974). Results were consistent with the generally held hypothesis (McCandless, 1967) that children from less educated environments give more prejudiced responses as seen in Figure 1.

FIGURE 1



Correlations with other scales. Numerous studies indicate a high correlation between prejudice and authoritarianism (Wilson, 1973). The rationale for this, which has been extensively illustrated by Bagley (1970), Kirscht & Dillehay (1967), and Wilson (1973), suggested a method for further examination of the validity and reliability of the measure, using the middle childhood authoritarian scale (Phillips, 1971a) as follows.

Rejection of ethnic groups on the LMSP (range 0-17) were calculated for those who had low scores (LAs) and high scores (HAs) on the authoritarian scale (Phillips, 1979a). A paired sample t-test in this and subsequent tests indicated that LAs rejected a significantly less number of ethnic groups ($p < .01$)

Distinguishing insularity and prejudice

The rejections on the LMSP were then sorted according to those supported by insular unfamiliarity type responses (labelled Type A) and those supported by prejudiced statements (labelled Type B) as previously defined. LAs were significantly less inclined to offer unfamiliar Type A responses than HAs ($p < .01$) and even less inclined to make Type B responses ($p < .01$).

An analysis (t-test as above) indicated a significant decline in Type A responses with increase in age from 9-11 years ($p < .01$). There was also a decline in Type B responses but it was less significant ($p < .05$). Children of 12 years were not included in the analysis because the results may have been confounded by the fact that the mean IQ in this age group was lower than in other age groups.

Interaction between ethnic groups

Many children in this study claimed that they did not wish social proximity with a number of groups because they were unfamiliar, thus suggesting limited ethnic interaction. As detailed checking of this interaction over a long period was not possible and as research outlined by McCandless (1967) suggests that children are much more reliable observers about events and relationships in their immediate world than adults give them credit for, the same sample of children were asked how many members of the various ethnic groups listed in the LMSP they had met. A random 10% of answers were checked where possible against teacher and parent estimates; intercorrelations were .94.

Cross-tabulations of stated preparedness to marry persons of a particular ethnic group and the numbers of people the child claimed to have met from that particular group (range: none, one, a few, a lot) indicated significant differences in favour of acceptance, the more familiar the child was with members of a particular ethnic group ($\chi^2 = 37.35$, $p < .0001$).

Prejudice among ethnic groups

Children from all ethnic groups revealed themselves as prejudiced towards other ethnic groups as Australian children, and often more so.

Table 2 gives percentage distributions of children expressing hatred toward other ethnic groups. Percentage distribution for insular and prejudiced statements are similar.

Table 2
Percentage of children within each ethnic group making statement

Target ethnic group	Statement: I hate them						
	Australian	British	Greek	Italian	Jugoslav	Lebanese	Middle East
Turkish	2.9	4.0	9.6	6.7	1.5	4.3	6.3
Japanese	2.1	2.8	5.2	2.2	3.0	4.3	3.1
Australian	0	1.6	3.5	0	0	0	3.1
Arab	3.1	4.8	7.8	5.6	9.1	4.3	6.3
Dutch	2.3	2.0	8.7	5.6	4.5	8.7	3.1
Italian	4.3	5.6	5.2	1.1	6.1	8.7	3.1
Palestinian	3.7	3.6	8.7	3.4	4.5	17.4	3.1
Chinese	2.4	2.4	8.7	3.4	4.5	4.3	3.1
Aborigine	2.5	3.2	7.8	5.6	4.5	8.7	3.1
Jewish	3.6	5.2	9.6	6.7	7.6	13.0	6.3
American	1.0	.8	6.1	1.1	0	4.3	3.1
French	2.8	2.4	5.2	3.4	4.5	4.3	3.1
Spanish	3.0	4.8	6.1	5.6	3.0	8.7	3.1
Jugoslav	4.2	3.6	10.4	7.9	1.5	8.7	6.3
Greek	5.1	7.6	0	9.0	1.5	8.7	0
German	3.4	2.8	8.7	6.7	6.1	8.7	3.1
Lebanese	4.5	6.0	12.2	13.5	7.6	4.3	9.4

Discussion

The results suggest that when the LMSP is scored for Type B responses it is a reliable indicator of prejudice in children and that it warrants further exploration.

More importantly, the method has thrown up a previously neglected factor and a possible confounding variable in the examination of prejudice in children. Further inspection of the unfamiliar or A type reasons ("they are not like us", "I don't like their customs") lead one to hypothesise that they are products of developmental egocentricity which needs to be distinguished from the negative hostility which is the central component of prejudice as in Type B responses ("they are wogs", "I hate them"). Children in middle childhood and pre-adolescence, with the limited ethnic experience of the sharp ethnic habitat divisions in Sydney, may still be sufficiently egocentric to be unable to accept routines, appearances, and customs, which are different from their everyday ones. In the past, this confounding variable (developmental egocentricty) has received little or no attention in the research on prejudice in children.

The fact that these unfamiliar, Type A, responses declined with age further suggests that they may represent developmental egocentricity. The hypothesis that Type A responses would decline at a significantly greater rate than prejudiced Type B responses, which possibly represent more basic and lasting attitudes in prejudice was not fully supported. In a previous study (Phillips, 1979b), it was demonstrated that authoritarianism declines with developmental age and it may be that prejudice is contaminated by similar tendencies in the early years.

The method thus highlights the importance of taking into account the developmental stage of cognition when studying children's attitudes. The formal thought of the researcher falsely extrapolated may create unnecessary complications and doubts. This could also be seen when the answers were pre- and post-checked for extraneous influences. For example, did the child reject the idea of marrying a Turk because he or she feared travelling to Turkey to do so? It became apparent that, as in other studies (Fein, 1978), future orientation at this concrete level involved thinking in terms of the conrete present. It was also clear that combinational thought was restricted as is typical of the level of concrete cognition (Piaget & Inhelder, 1968). Hence the vast majority of the children accepted the question and required answer as involving two possibilities, namely acceptance or rejection of an individual or an ethnic group. Those, who saw a larger range of issues or combinations, which might have bearing on their choice, or who could project out of the concrete present into the future, comprised a mere 4% of the population interviewed.

In attempting to take into account a hitherto little explored dimension in the examination of prejudice in children, namely the child's method of judging and evaluating in terms of his or her cognitive level of functioning, the slight similarity with the Bogardus scale has not escaped notice. It is interesting that a method derived directly from the children's techniques of evaluation should prove to have something in common with the techniques of the founding research into examining prejudice.

The findings also supported by past and overseas research, indicate that typically prejudice is directed toward "out groups", or groups that are in a less dominant position (McCandless, 1967). Hence, since Australia is the host country, with a powerful and affluent middle and working class, Australians were the most favoured group on the LMSP and the ones towards whom there is least prejudice.

The results also suggest that children, at least at this age, tend to favour ethnic groups with whom they have friendly contacts and to reject those with whom they are least familiar. This source of familiarity may be variable. For example, the claims by many children that they had met a lot of Americans and 47% a few (which correlated with a high acceptance rate of Americans) may arise in many cases from high TV exposure to the American way of life. It matters little. In such an event, television's presentation of both negative and positive aspects of Americans is providing a force which increases familiarity and, therefore, the preparedness for social proximity. Biased portrayals (exclusively positive or negative) may inadequately prepare the child for incongruent encounters and may induce prejudice.

As well as realistic TV portrayal to familiarise children with less-favoured ethnic groups, some attempt to overcome the ethnic habitat divisions in Sydney (Davis & Spearritt, 1974) might be made by providing more opportunity for constructive meetings between children of different ethnic groups. For example, few migrants live on Sydney's upper north shore, which is the enclave of Australia's well-to-do, well-educated middle classes and professional groups. Even within Sydney's western, southern, and eastern suburbs, where most migrants live, there are different enclaves of particular ethnic groups.

In discussing the findings and educational measures, it is recognised that historical and political conflicts of the ethnic groups of origin inevitably influence the child's attitudes. Some of these are suggested by the variations in percentages in Table 2. Similarly, as Nias (1974, p.110) indicates, racial prejudice is likely to develop where people are threatened economically by groups which can clearly be labelled according to ethnic and other differences. Parents tend to hand on these prejudices to children. These are all factors which need to be considered in the much-needed further exploration of prejudice in children.

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THE ORIGINS OF SELF: A NEW SUBJECT FOR COGNITIVE DEVELOPMENT RESEARCH?

Michael Booth
Murdoch University

Most of the literature in social and humanistic psychology seems content to regard "self" as a useful and relatively unproblematic term on which to hang a number of important and complex research areas: self-concept, self-esteem, self-actualisation have all had many devotees. Despite the problems of both definition and of experimental demonstration (Gur & Sackeim, 1979) "self-deception" has been invoked (Anastasi, 1961) in accounting for invalidity of self-report. Even self-report, an unexceptionable remembering of past activities, thus retains, a half-century after the behavioural resolution of problems with introspection, an unexamined suggestion of inner complexity.

Wegner and Vallacher have recently written a book (1977) that takes as its subject matter a field of studies which they name Implicit Psychology. This includes all those studies from Heider to Piaget that have widened our understanding of the psychological conceptions that people form of other people. Each chapter includes a summary of developmental changes in social cognition (mostly based on some aspect of Piaget's studies). The earliest stage cited in the analysis of self-development is based on the work of Selman (1976). It is the egocentric level in which "Although he can differentiate between self and others as entities, he does not consider the possibility that other persons can have other points of view". Even here there is no discussion of the development of an idea of "self" itself, as entity.

The situation in philosophy is of course quite different; "self" has been a concept with no clear reference for as long as there have been problems about the relation of mind to body. Hume followed Locke's empiricism in trying to account for human nature on the basis of impressions formed upon a tabula rasa. An outcome of the logic of this position, according to Hume, is that the reference for "self" can be nothing other than a bundle of sense-impressions. Much of the subsequent debate, including views of "self" as an entity outside those sense-impressions, as subject or as spatio-temporal identity, can be found in two books of the very recent past (for philosophical work):
C.O. Evans, The subject of consciousness, London, 1970, and,
S. Shoemaker, Self-knowledge and self-identity, Ithaca, New York, 1963.

The straightforwardness of most psychologists since Watson, together with the strategy of studying the behaviour of the body, and letting mind manifest itself in the analysis as higher mental processes will, has produced far less intractable confusion in psychological research. The reference of "self" has it seems to me been understood on the analogy of a person's pointing at herself and indicating an undoubted part of the physical universe. Self-concept, self-regard and self-esteem, even self-actualisation, have then all been understood without any immediate confusion, as involving a person's concept, regard for, estimation of, and attempts to develop that very same person as she would point to in indentifying her self.

Let me say immediately that I have no wish to challenge that straightforwardness on purely logical grounds. I am concerned rather with a matter for empirical research--namely the development of cognition within the human organism. (And I shall assume here that I can, without loss of ultimate scope, speak for now of this development as being within the human brain). From this perspective, cognition of self as entity is problematic; even as an early stage in the empirical sequence of development this cognition must be seen as the termination of a still earlier series of cognitive developments.

Take for instance the levels of information processing defined by E. Roy John in his paper on consciousness which opens the series Consciousness and Self-regulation, edited by Schwartz and Shapiro (1976). Irritability, present in protozoans, and involving the excitation of organs and the possibility of reflex responses is for John first-order information (that he already calls "sensations"). When these interact with information stored earlier there is constituted second-order information, which he terms "perceptions". A combination of information from multiple modalities into a unified multidimensional representation is third-order information (consciousness); from this feedback occurs to the more fundamental levels of memory, attention, emotion, perception. So far what is postulated corresponds closely to Freud's ϕ, ψ and ω classes of neuron in the 1895 project for a scientific psychology recently resurrected and judged of contemporary significance by Pribram and Gill (1976).

John has not yet reached the level of information corresponding to subjective reality, nor any level on which that could become the basis for a distinction between self and other. "Subjective experience" he writes, "derives from information about the content of consciousness. It is a process which reorganises the sequential series of events into a single experiential episode. . .". This generates fourth order information and enables two critical transformations to occur. Firstly there are evoked memories related to this holistic event, and secondly, "the accumulated memories of sets of fourth order information constitutes the basis for what we call the self". The individual historical record involved is information of the fifth order.

But for John there is yet another step before self-awareness is achieved. Sixth order information is the interpreting of subjective experience (fourth order information) in terms of the previous history of life experiences of the individual (in terms that is of fifth order information).

How theyoung child for whom Piagetian formal operations are far in the future, succeeds in these integrative mental activities, to form some notion of the conservation of "self" is unclear. While we must acknowledge I believe a complexity at least equal and perhaps greatly exceeding that outlined by John, it leaves us with two alternatives. Either this conceptual machinery forms through maturation according to an innate plan, or it comes about gradually through social experience and so is not present at the earlier stages of that social experience. Which of these alternatives occurs is I think an empirical question, but one that has been largely ignored, with the too easy assumption of a sense of "self" that is somehow naturally present.

The French psychologist, Jacques Lacan, an important influence on structuralist thought in France (which attempts to locate social relations in conceptual (symbolic) frameworks), has put forward a theory of the basis for the ego (see Wilden, 1968). This basis is "the mirror stage" an early phase in child development described by analogy with the experience of seeing a mirror image, but requiring only the visual perception of a similar being. According to Lacan, in so far as the intersubjective relationship is influenced by the effects of the mirror phase, it is imaginary (constituted through the image of a similar being) and so given to a duality, alienation and aggressive tension, resulting from the constitution of ego as "other". These ideas are far from straightforward and Lacan's work is hard to locate and for most people from English-speaking cultures both convoluted in style and obscure in its allusions. I will enlarge on some of the threads for further study that can be separated out from this notion.

Most importantly I believe there is here an echoing of ideas to be found in Freud's Project, and here I shall quote at length from the Standard Edition, Volume 1.

> . . . the perceptual complexes proceeding from this fellow human being will in part be new and non-comparable - his features, for instance, in the visual sphere; but other visual perceptions - e.g., those of the movements of his hands - will coincide in the subject with memories of quite similar visual impressions of his own, of his own body, (memories) which are associated with memories of movements experienced by himself. (p. 331).
>
> The perception may correspond to an object-nucleus + a motor image. While one is perceiving the perception, one copies the movement oneself - that is, innervates so strongly the motor image of one's own which is aroused towards coinciding (with the perception), that the movement is carried out. Hence one can speak of a perception having an imitiation-value. (p. 333).
>
> As regards judging, there is further to be remarked that its basis is obviously the presence of bodily experiences, sensations and motor images of one's own. (p. 333).
>
> Thus, judging, which is later a means for the cognition of an object that may possibly be of practical importance, is originally an associative process between cathexes coming from outside and arising from one's own body - an identification of information or cathexes from ϕ and from within. (p. 334)

Here Freud places the development of all judging, or cognitive thought, in the perception of another and the association between cathexes from outside and arising from one's own body. It is not only the development of an "ego" that is here at issue, but the emergence of all possibility of cognition. With the separation of those bodily movements which the infant can with jubilation bring about, from those which with great frustration the infant must eventually relinquish to another (as movements of the body of another), will come not only the cognition of self and others but of otherness in general. Here I think lies the origin and meaning of Lacan's stress on duality, alienation, aggressive tension.

But there is as well the "imitation-value" of those important others who furnish most of these early perceptions. The very achievements of control which come about through the infant's slowly maturing bodily coordination are themselves parasitical upon the alien movements of these others. The ego as it forms is always itself a reflection of these others; the image in the mirror cannot be reached, but nor can the self that is forming, it is made in the model of what other people do, and so by its very nature not me here, but that there, and so in an important sense "imaginary". Lacan indicates the origins in these early experiences of the Cartesian separation of mind from body, but as usual we have to pull together the threads for ourselves.

What is imitated includes sounds, and of course sounds are the basis for speech and, as Freud indicates in the Project, for an early form of recognition.

> . . . In the first place, there are objects - perceptions - that make one scream, because they arouse pain; ... when otherwise, owing to pain, one has received no good indication of the quality of the object, the information of one's own scream serves to characterise the object. Thus this association is a means of making memories that arouse unpleasure conscious and objects of attention: the first class of conscious memories has been created.
>
> (p. 367)

Freud continues this passage in consideration of "the trend toward imitation, which emerges during judging" and leads to invention (in the infant) of speech. This invention of speech follows closely upon the first class of conscious memories and like them is closely linked to the experience of pain and a way in which it comes to be avoided.

> . . . Speech innervation is originally a path of discharge for ψ, operating like a safety-valve. . . it is a portion of the path to internal change, which represents the only discharge till the specific action has been found. This path acquires a secondary function from the fact that it draws the attention of the helpful person (usually the wished-for-object itself) to the child's longing and distressful state; and thereafter it serves for communication and is thus drawn into the specific action. (p. 336).

The cultural response of another to what is at first non-specific and arbitrary discharge, makes of that discharge, a gradually refined specific act, which is communication.

At this point we have reached the centre of the problem with which this paper is concerned. I hope now to make clear why I should be resurrecting some work of Freud that is 85 years old in an area in which there is comprehensive and valuable recent work (for instance, Brown, 1973, and Halliday, 1975) that has found no need to make reference to Freud's work on language, communication and action. Firstly there is evidence and argument to support a close relationship between early language development and action; Rogdon et al. (1977) point out "our data confirm the notion that language arises in conjunction with overt action" and refer to the themes and research of de Laguna (1927), Piaget (1952), Sinclair (1971), Werner and Kaplan (1963). But secondly, as Howe (1976) points out, many have assumed that a young child shares enough of the mental organisation and communicative intent of adult speakers to be expressing in early utterances one of the meanings which an adult can express. This assumption is not easily supportable, yet we (adults) have no way of specifying the conceptions of children independently of the conceptual structure of our own language and cognitive processes (a point made by Rodgon, 1977). Furthermore we easily fall into adultmorphic talk even in characterising the most elementary operations in the child's constructing of reality. In Freud's 1895 Project the construction of a model for brain activity ties the theorist down in her use of such terms, so that the conceptual structure employed has to be made clear for the model to be explicit and definite. In this context "finding the specific action" for example can be understood in reference to the process of hallucinatory wish-fulfillment by which a prior occurrence becomes manifest to the limits of the infant's imitative or productive capacity. The infant creates mother,through creating all that is associated with mother that the infant can create. This is not purposeful calling in the adult sense, but it is "a system which will evolve into adult language" in Rodgon's (1977) words, where she states what should be sought in place of the analysis of child language as if it were adult language. By speaking of hypothetical brain processes the scientist's ontology does not become confused with the child's ontology, and so questions about the conceptions and consciousness of the child become easier to formulate in terms that do not rest upon culturally variable notions (and these include even it might be argued "consciousness", and also "concept").

In avoiding adultomorphic errors in accounts of language development in young children theorists face problems involved in the early stages of the development of the cognitive labelling of bodily states (cognitions such as are discussed for instance by Singer and Schachter, 1962). The infant is seen in many studies as engaged from the start (of the development of language skills) in a game of naming in which the words culturally appropriate for referring to objects in the world are gradually acquired and honed down in meaning. Such a process is clearly more problematic where internal bodily states are being labelled.

The issues involved extend to the appropriate identification of "self". If there is an awareness of self as a distinct physical entity before language games develop, then this will affect the use of "Mary", "I", "you", etc.; the associated brain developments will be those involving the attachment of appropriate labels to already conceived entities, so that the possibility of verbal labelling supplements an already existing possibility of identification, i.e., for the child in this case "That over there is something or other", maybe it is called "Mary", maybe "you", or maybe better to say "I...". On the other hand I think it is not clear that there need be an awareness of self as a distinct physical entity before observed language games come to be played. The infant can play with sounds, calling out "AAaai" or "Aaagh" long before these sounds have any unique reference, and be gradually shaped to make these sounds in appropriate contexts. On this second model it could be maintained that it is only through the language game that self-awareness comes into being. The associated brain developments will then be, not attaching labelling possibilities to already conceived entities, but rather developing conceptions through extrapolation from more or less concrete supposed reference. What I should like to open up discussion about, is which of these sequences occurs. Does the infant first form an awareness of self and agency and gradually get the labelling right? Or is the awareness of self and agency a result of language games being played? Is this awareness--John's sixth order information--a late development, that rests upon cultural terms and the experiences of communication?

As well as proposing this question of the development of an awareness of "self", I hope to leave you with the conclusion that in the case of this concept at least, the question of which comes first--concept or naming --is empty except insofar as it is construed in terms of brain processes. It then becomes clearer that what is at issue is not the ordering of two related developments: The concept of an object, and the naming of that same object. Rather the question is one of ontology, closely paralleling that of the philosophers. The question of the ontology of "self" is I conclude, a neuropsychological issue for all cognitive developmental researchers, an area for study which Freud and Lacan, at least, have already opened up.

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INFANT CRYING AND MATERNAL RESPONSIVENESS: A LAG SEQUENTIAL ANALYSIS

Carmen Lawrence
University of Western Australia

It is generally assumed that the amount of infant crying can be readily modified by parental practice (Bell & Ainsworth, 1972; Gewirtz & Boyd, 1976). Jolly (1975), for example, advises parents to respond promptly to all the infant's cries on the assumption that this will actually reduce the amount of crying later on. This is in sharp contrast to earlier professional opinion which stressed that babies would cry more if their demands for attention were always successful.
Despite this obvious shift in advice, there is no good evidence to support either position and very little data on the long term effects of various patterns of parental response to crying. More importantly, the extent to which variations in infant crying might result in changes in caretaker behaviour has been largely overlooked.

Three models of the possible long term relationship between infant crying and maternal responses to that crying emerge from a review of the literature (Figure 1).

The first, developed by Bell and Ainsworth (1972), depicts the mother as the driving force in the relationship. The authors argue that the frequency and duration of crying and the ease with which an infant can be quieted have minimal impact on the mother's responsiveness, viewed in the long term. On the contrary, they claim that "consistency and promptness of maternal response is associated with decline in frequency and duration of infant crying" (p. 1171). Empirical support for this view is derived from their 1972 longitudinal investigation of 26 mothers and their infants observed at home at 3, 6, 9 and 12 months after the birth of the infants. However, their analysis and interpretation of the data have been extensively criticised (Gewirtz & Boyd, 1977; Gewirtz, 1977; Parsley & Rabinowitz, 1975). Not only do they use non-parametric rank correlations instead of more powerful techniques such as cross-lagged panel correlations, but a close examination of their table of intercorrelations indicates that the pattern of positive correlations found is compatible with both "mother-influences-infant" and "infant-influences-mother" hypotheses. Finally, their observations did not commence until the infants were three months old, by which time considerable change might already have taken place.

Gewirtz and Boyd (1977) insist that the relationship between infant crying and maternal responsiveness is one of mutual influence. They propose that "at the same time a caregiver's behaviour may be conditioning (reinforcing) responses of her infant, the infant's behaviour may be conditioning the caregiver's own responses" (p. 109). In addition, Gewirtz (1977) disputes the direction of maternal influence. He cites his own laboratory demonstration of the conditioning of infant crying as evidence that ignoring cries and reinforcing competing responses

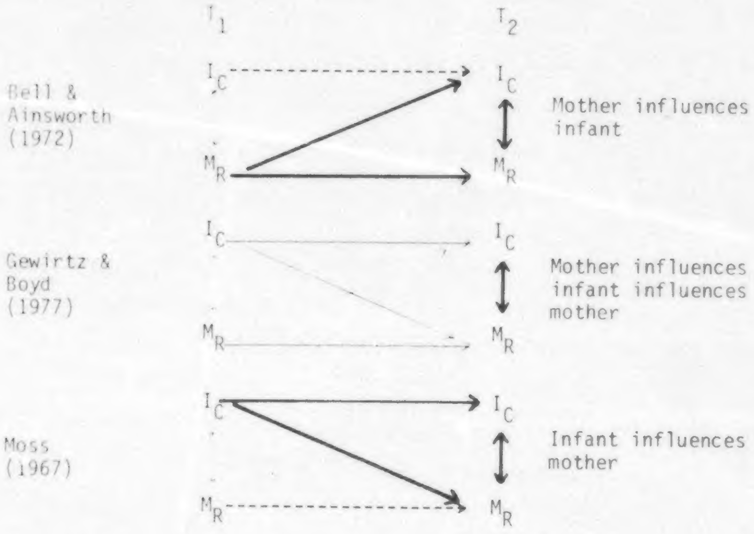
T_1
T_2
Bell & Ainsworth (1972)
I_C
I_C
M_R
M_R
Mother influences infant
Gewirtz & Boyd (1977)
I_C
I_C
M_R
M_R
Mother influences infant influences mother
Moss (1967)
I_C
I_C
M_R
M_R
Infant influences mother

Figure 1: Three models of the long-term relationship between infant crying (I_C) and maternal responsiveness to cries (M_R).

------------- : Weak association

____________ : Moderate association

———————— : Strong association

(e.g., smiling) will actually decrease the amount of crying in the long term. Furthermore he argues that in relation to the Bell and Ainsworth (1972) study it is conceivable that mothers who often ignored crying were maintaining certain classes of their infants' cries through intermittent schedules of reinforcement.

The third model, which has not been formally described, depicts the infant as a more powerful force in shaping the mother's response to crying. Evidence consistent with this model is provided by Moss' (1967) study of 30 firstborn infants and their mothers. He showed that infants who fussed a great deal at three weeks of age continued to do so at three months. Mothers of the extremely irritable infants, while among the most responsive at three weeks, were found, three months later, to spend less time in interaction with their infants than mothers whose infants were initially less irritable.

The basic problem in comparing the adequacy of these models lies in the different data bases required. Bell and Ainsworth (1972) used global, summary measures of maternal and infant behaviour, i.e., frequency and duration of cries and number of cries ignored and duration of unresponsiveness. Gewirtz and Boyd (1976), however, insist that it should be possible to specify the contingent relationship between infant cries and maternal responses. In particular they propose that any examination of the long term effects of one on the other should employ a behavioural description and analysis which enables: (a) the identification of classes of crying which constitute a functional unit with respect to contingent maternal response (e.g., short duration, low intensity fusses vs short duration, high intensity cries), (b) the specification of reinforcement schedules where these are operative, (c) the description of environmental characteristics (including maternal characteristics and behaviour) which are discriminative cues for infant crying and, (d) the identification of contingent maternal responses which are reinforcing. This obviously requires a much finer description and analysis than that provided by Bell and Ainsworth (1972) or Moss (1967).

To ascertain the validity of the models described it was considered essential that data be collected so that measures derived would be compatible with the requirements of each model, i.e., precise specification of the moment-to-moment behaviour as well as global measures of frequency and duration. The strategy which seemed to satisfy these requirements, and the one employed in this study, was naturalistic observation of spontaneously occurring mother-infant interactions recorded in real time.

Data were generated in such a way that the summary statistics could be analysed in terms of causal models (Rogosa, 1978) designed to untangle the long term reciprocal effects of infant crying and maternal responsiveness. These data will be reported elsewhere. The mutual contingencies operating between mother and infant, which presumably mediate the long term effects, were separately examined to address the questions posed by Gewirtz (1977). Although 51 mother-infant pairs were observed from two weeks after birth until the infants were six months old, data from only two mother-infant pairs will be reported here. It was necessary to analyse individual rather than group data, since the contingencies operating and the effects of various patterns of mutual conditioning would have been masked by pooling data to give group results. The two pairs, whose results are described, were selected for illustrative purposes because they were very similar at two weeks but clearly different by the six month observation.

Method

Subjects. The subjects were two married, middle class women and their firstborn female infants. Both infants were born of uncomplicated deliveries and were normal and full-term at birth. One mother was 26-years-old and the other 29. Both had completed high school education and held professional employment.

Data collection procedures. Observations were made during three 2-hour home visits when the infants were 2 weeks, 3 months and 6 months old. A portable electronic recording device similar to the commercially available Datamyte 900 was employed.[1] This unit allows for real time sampling of interactional data, providing for the identification of time of onset of every codeable event, the elapsed time between onset and offset, and the entry of up to 26 mutually exclusive codes in either of two channels, one for maternal and one for infant behaviour. This means that, in addition to precise specification of the frequency and duration of events, it is possible to preserve the order of events within the limits of observer accuracy. Real time sampling was selected in preference to modified frequency or event recording techniques, both of which introduce serious distortion into the data base (Bakeman, 1978; Sackett, 1978; Sanson-Fisher et al., 1979). In particular, the contingencies operating within and between individuals are misrepresented and the unconditional probabilities of events, necessary for a strict interpretation of contingencies (Sackett, 1978), cannot be estimated by these methods.

Data analysis procedures. The lag sequential analysis procedure devised by Sackett (1978, 1979) was used to analyse the relationships between maternal and infant behaviours. Basic to Sackett's (1978, 1979) model is the concept of the event or time lag. He outlines several relatively simple steps in the application of the lag technique: (a) choice of one of the coded behaviours (e.g., crying) as a criterion event, (b) calculation of the frequency with which every other behaviour follows the criterion as (1) the very next event (Lag 1), (2) the second event (Lag 2) up to (3) Max. Lag, the longest sequential step of interest. For each criterion investigated, event lags indicate the number of times each instance of the criterion is followed by all other coded behaviours up to the Max. Lag event. Time lags are calculated in the same way, except that data are lagged in successive real time intervals rather than sequences of events. For both event and time lags conditional and unconditional probabilities can be calculated for each behaviour in a given interaction.

The choice of time lag procedures required that the investigator make two decisions prior to conducting the analysis. Firstly, the time unit in which behaviours are to be lagged must be selected so that the unit is sufficiently brief to ensure that one and only one behaviour can occur in that interval. One-second units were chosen for this analysis. Secondly, the investigator must decide where to start lagging. Sackett's (1979) procedure allows for three possibilities. The first, a level trigger, initiates lagging after every 1-second instance of the criterion. The second method initiates counting at the offset of the criterion event (trailing edge) and the third method uses the onset of the criterion event as the trigger (leading edge), with behaviours being counted at each 1-second lag from this point. Both leading edge and trailing edge as well as event lag procedures were employed in this analysis.

Once obtained, the lag probabilities were tested for statistical significance against the null hypothesis that the probability of any behaviour following the criterion at any lag is completely random. For event lags, this means that the hypothesis tested was that a particular behaviour would precede or follow the criterion at any lag only in proportion to its occurrence in the data as a whole--its unconditional probability. For time lags the hypothesis was that a behaviour would precede or follow the criterion event in proportion to its occurrence at any randomly selected 1-second instance in the time sequence observed --its proportion of the total test time. The chi-square statistic was used to test for significant differences between observed (conditional) and unexpected (unconditional) probabilities.

Results and Discussion

Reliability. Inter-observer reliability was assessed by calculating the coefficient Kappa (Cohen, 1968) for behaviour observed in randomly selected five minute segments of jointly coded naturalistic and video-taped mother-infant interactions. Satisfactory reliability estimates were attained for all codes reported here. Inter-observer agreement was deemed satisfactory if Kappa coefficients significant at $p < .05$ were obtained on more than 85% of the occasions a given behaviour category was recorded.

Changes in crying and maternal responsiveness

Table 1 shows changes over the six months in the amount of crying and in maternal responsiveness. For these two infants there is, as typical for the group as a whole, an apparent decline in the frequency and duration of cries. It should be noted that duration of cries is a

Table 1
Frequency and duration of cries, % cries to which response given and duration to respond

Observation	Mother-infant pair	Frequency of cries	Mean duration of cries (in seconds)	% cries to which response given	Mean duration to respond* (in seconds)
2 weeks	A	39	16.23	100%	5.43
	B	37	14.07	97%	5.17
3 months	A	27	11.70	100%	6.21
	B	31	13.44	71%	6.92
6 months	A	20	10.32	95%	6.74
	B	14	11.07	71%	7.05

*This figure is calculated from those cries to which a response is given.

composite measure which varies as a function of the proportion of cries to which the mother responds, her promptness in responding, her effectiveness in terminating cries and the ease with which the infant can be quieted. Given the small N and the fact that independence of observations cannot be assumed, no formal statistical comparisons have been made. However, it seems clear that mother B, unlike mother A, changes from a policy of responding to all cries (continuous reinforcement) to one of ignoring approximately one quarter of her infant's cries (partial reinforcement), although she continues to be prompt when she does respond.

Lag sequential analysis enables a more fruitful comparison of the patterns of response characteristic of each of these mothers. Results of such analyses indicate events which are significantly contingent on crying (Table 2) and, taken together with results presented in Table 1, allow for the questions posed by Gewirtz (1977) to be addressed.

An examination of Table 2 (Column 2) shows that no discriminative cues for crying are evident for either infant at two weeks. However, at three months, mother putting the infant down (A and B), moving out of sight (A and B), and interrupting feeding (A) are events now clearly linked to the onset of crying. At six months, restraint or prohibition of the infant's activities or the infants hurting themselves are additional antecedents to cries. It should be noted that other cues, not discernable using the relatively global coding system employed in this study, may be operative.

As indicated in Table 1, both mothers respond to all cries at two weeks and lag analysis does not reveal any connection between the antecedents of cries and maternal responses, i.e., there are no distinguishable classes of cries which are functionally related to maternal response. However, at three months when antecedents can be specified, an analysis of those cries which mother B now ignores shows that they are the ones precipitated by her putting the infant down or moving out of sight. By six months, these events no longer precipitate cries for her infant. In behavioural terms, mother B ignores the class of cries resulting from her moving out of contact and seems to succeed in extinguishing them by six months. It is important to note that despite the different strategies adopted in relation to crying, both mothers spent similar amounts of time in interaction, were equally active during interactions, and had comparable profiles of responses conditional on the infants' smiling and vocalising. This is in contrast to Bell and Ainsworth's (1972) claim that mothers who ignore a significant proportion of cries are also likely to be relatively unresponsive at other times.

The final issue is that of determining which maternal behaviour is linked to the termination of cries, i.e., in behavioural terms, what events are reinforcing. At two weeks, a trailing edge analysis indicates that picking up (A and B), rocking (A) and feeding (A and B) are all more frequent than would be expected by chance. At three months, the same events as well as the mother returning to the field of vision are associated with the offset of crying for infant A, but not for infant B. In her case, no events are reliably tied to the offset of crying. However, her mother ignores 29% of her cries and, when these are excluded from the analysis, the same events as for infant A (except

Table 2
Summary of events significantly* contingent on onset and offset of crying for both infants at 2 weeks, 3 months and 6 months

Observation	Infant	Events		
		Onset Cry (Leading edge)	Cry (Events Lags Analysis	Offset Cry (Time:Trailing Edge)
2 weeks	A	None	M.Picks up I M.Adjusts hold I. M.Carries I. M.Burps I.	M. Picks up I. M. Rocks I. M. Feeds I.
	B	None	M.Averts gaze I. M.Picks up I. M.Rocks I. M.Physical affection I.	M. Picks up I. M. Feeds I.
3 months	A	M. Puts down I. M. Moves out of sight I. M. Interrupts feed I.	M.Picks up I. M.Carries I.	M. Picks up I. M. Returns to sight I. M. Feeds I. M. Rocks I.
	B	M. Puts down I M. Moves out of sight I.	M.Picks up I M.Rocks I. M.Offers toy/object I	None
6 months	A	M.Puts down I. M.Moves out of sight I. M.Restrains/prohibits I Hurts self	M.Picks up I. M.Returns to sight I. M.Physical affection I	M. Picks up I M. Returns to sight I.
	B	M.Restrains/prohibits I.Hurts self	M.Picks up I M.Plays/entertains I.	M. Offers toy/object I. M. Plays/entertains I.

* p <.01

for rocking) are seen to precede the termination of cries. These results are comparable with Bell and Ainsworth's (1977) findings that picking up and feeding are the most effective maternal interventions. However, the lag analysis provides the additional information that these events are significantly more likely at the cessation of a crying than would be expected from the overall frequency in the sequence observed. The six month data show that mothers A and B have adopted different strategies in response to crying (Column 2) and their infants now stop crying in response to quite different interventions, close contact for A and entertainment and distraction for B.

Conclusion

These results, although far from complete, do indicate that it is possible to unravel some of the complexities of mother-infant interaction in terms of the questions posed by Gewirtz (1977). For example, the classes of cries which clearly behave as functional units with respect to maternal response vary between individual mother-infant pairs and across time. This is clearer with mother B, perhaps a behavioural engineer at heart, who adopts a strategy of ignoring cries precipitated by her moving out of contact.

In arguing that the practice of ignoring some cries results in increases in crying, Bell and Ainsworth (1972) appear to assume that systematically ignoring certain classes of cries and randomly ignoring cries are equivalent in their effects. Lag analysis indicates that this assumption may not be justified. Using the technique outlined here, the full range of contingencies operating between infant crying and maternal responsiveness will be analysed for the remainder of the sample in order to determine the differential consequences of each pattern of maternal responsiveness on longitudinal changes in crying. The results given here are a preliminary attempt at such an analysis.

Footnote

1. The device (DART II) was developed within the University of Western Australia, Department of Psychitary and Behavioural Science in collaboration with the Department of Biophysics, Sir Charles Gairdner Hospital. Details of its construction and operation are given in Sanson-Fisher, Poole, Small and Fleming (1979).

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LEVELS OF DESCRIPTION AND EXPLANATION IN STUDIES OF MOTHER-INFANT ENGAGEMENT AND INTERACTION

Alan Hayes
University of Queensland

The match between theory and method

There is, at present, a basic disjunction between theoretical interpretations of social phenomena in infancy and the methods used to study such phenomena.

On the one hand, theory increasingly uses constructs such as "intersubjectivity" (Newson, 1974, 1977; Newson & Newson, 1975; Trevarthen, 1977) "shared meaning" (Newson, 1974), and "joint reference" (Bruner, 1977). Such terms raise the question whose "subjectivity", "meaning" and "reference" are involved? Three sets of meanings are surely involved. First the researcher's in attributing the constructs to the characteristics of the stream of behaviour observed. Second the infant's, in whatever inchoate form meaning structures exist for the child at this stage. Finally the parents'. Sameroff and Harris (1979) contend that the child's parents effectively "control and operate the interpretive schemes" by virtue of their "control over the public meaning system" (p. 363). The parents are the social mediators of the child's world of meaning (Newson, 1974).

Viewed in this way, the parent and the psychologist observing the infant are faced with similar problems of interpretation. Both face uncertainty of interpretation brought about by a difference between adult and infant abilities to communicate meaning. Whereas adult interpretations of adult behaviour can be validated by communicating with one another (Pribram, 1971), and arriving at an agreed interpretation, the prelinguistic infant is not yet socialised into the system of socially aligning frames of reference and meaning. The process for adults is essentially one of comparing definitions of constructs. Constructs are the coin we use in socially dealing with the phenomenal world. They enable the delimiting and organisation of that world. From an Hegelian perspective the objects in the world can have ". . .an infinite number of properties or relationships" for which the subject possesses a "finite set of categories for these properties" (Sameroff & Harris, 1979, p. 343). Meaning is not inherent in the object per se but in the constructs used to describe any object. This is also the case for behaviour as object. In the context of communication this implies that the meaning of a gesture cannot be assumed from the form of the gesture per se (Newson, 1977).

Consistent with the emerging Zeitgeist in developmental psychology, the organisations or structures into which experience is assimilated are widely viewed to be dynamic. Categorising and interpreting imply the organisation of the behaviour of the actor by the observer. The mind of the observer is, in this sense, viewed as a transducer of experience (Kagan, Kearsley & Zelazo, 1978). The observed activity of the object, or the "other", is also dynamic.

> . . .From the active-organism perspective, the flux of behavioural appearances is the given and it is necessary to establish or construct or represent stability in the face of change; being in the face of becoming; permanence in the face of impermanence. . . .
>
> (Overton, 1976, p. 81)

But, to what extent have such active organism notions affected research? The study of mother-infant interaction is, it seems, still showing the pervading influence of mechanistic, "passive organism", models. The methodological approach to socialisation phenomena in the last decade seems to have been framed within a mechanistic model, despite lip-service to active, organismic approaches. The current style of micro-analyses of the temporal organisation of discrete behaviours is an example of the persistence of mechanistic models.

Some features of methods to date

In the sixties, Altmann (1965) applied stochastic modelling to the communicative behaviours of rhesus monkeys. Interestingly, Altmann's research addressed the problem of ". . .understanding the selective factors that led to the accretion of the ability to base present action upon a large store of remembered and socially communicated past experiences" (p. 491). However, subsequent applications to human communicational behaviour have taken a very simplistic view of that "ability" to act on previous experience. The adoption of a Markov model imposes a mechanistic conception of cognition and memory upon the process of communication. As Schaffer (1977) comments ". . .it seems likely that a cumulative effect of previous events in a far from simple additive manner ought ideally to be taken into account, thus making simple Markov chain models even less applicable" (P. 8). The problem of insufficient, or inappropriately modelled, "memory" is only one of the limitations of applying Markov models to human communication. The content of Markov analyses--discrete acts, events or states--is also problematic. First, the number of possible combinations of dyadic states that can be generated from even a restricted set of categories of communication rapidly becomes enormous (Collis, 1977) and this makes analysis and interpretation difficult. Second, and even more fundamentally serious, dyadic states are, as the word state implies, static. But what constitutes an act, event or state? As applied in mother-infant research, dyadic states have derived from codings of either single behavioural events or clusters of events. There has been a tendency to oversimplify the range and nature of the behavioural acts, events or states to be included in the analysis. This has, in part, been the product of researchers' predilection for variables that offer reliability of coding and manageability at the stage of data reduction and analysis. It has also been the result of the recent focus on the capabilities of the infant. As Parke (1978) suggests:

> . . .in our enthusiasm to give the infant proper recognition as a contributor to the interactive process, the assumptions have been oversimplified concerning the partner's capacities in the dyadic exchange by treating them as coacting equals. . . .
>
> (p. 76)

In short, the analysis has been based on those behaviours that both mother and infant emit. As a result, the fundamental difference in the behavioural complexity of mother and infant has been unwittingly reduced.

An artificial equivalence is also imposed on all of the occurrences of an act, event or state in a particular category in current applications of microanalytic event recording techniques. Irrespective of where it fits contextually into the actor's stream of behaviour, an act, event or state is functionally equivalent to every other occurrence, by virtue of the fact that current event researchers are unable to assign differential weights to the several occurrences of a discrete category of behaviour. And current researchers have yet to define the weights that should be applied if event recording techniques permitted. As such the fluctuating salience of the constantly labile stimulus array of mother and infant is ignored. This trend reflects the continuing emphasis in psychology upon frequencies and latencies at the expense of consideration of the intensity of behaviours (Hartup, 1979). Apart from the obvious psychophysical connotations of "intensity", the term also raises issues of salience; and salience introduces considerations of the subjective impact of behaviour upon the observer (whether participant or researcher).

A possible change in method

Issues of salience and meaning have been avoided by defining the acts, events or states from the researcher's perspective. Duncan and Fiske (1977), for example, define the act as "the smallest unit of observation used by an investigator but not further subdivided or analysed in a given study" (p. 309). This is a convenient, but not compelling, definition. As Bullowa (1975) points out ". . .there is always a problem of when to stop looking at smaller-and-smaller-sized units" (p. 114). But what is an appropriate basis for deciding on the "natural" units of analysis?

Altmann (1965) provides the following guidelines: "one divides up the continuum of action wherever the animals do" (p. 492). Altmann's position raises a crucial issue for the study of social engagement and interaction in infancy: How does one decide where the infant has divided the continuum of action? In other words, what constitutes sufficient evidence of the infant's segmentation of the stream of another's behaviour? Perhaps the surface topography of the infant's behaviour is not a sufficient basis for imputing effects of the mother on her child. Simply put, how much, and what features, of the mother's behaviour is the infant processing and how is this information being organised? Currently, these are questions that have not been addressed in studies of mother-infant interaction, except in cursory fashion.

Given the problems of defining acts, events and states, why then, has the discrete behavioural approach persisted as the primary approach to the study of engagement and interaction? The answer, in part, lies in the "safety" of dealing with discrete behavioural categories at a micro-level of analysis. If a mechanistic model is adopted, and the subjective importance of behaviour ignored, then precise definition of the act, event or state by the observer is scientifically appropriate and defensible. The only problem becomes significant when an attempt is made to link activity at the micro-level to organising principles at the macro-level. The introduction of a cognitive processing, active organism into the picture changes the scene quite fundamentally. Once constructivist conceptualisations are admitted, the definition of acts, events or states in isolation from the actors is no longer sufficient.

The act of even recording involves certain assumptions about the way the stream of another's behaviour is perceived. Apart from the problem of functional equivalence of the units, discussed earlier, the act of event recording also involves untying features from the covarying relationship they have to the other contemporaneous aspects of the behavioural stream. At present we have insufficient knowledge of how features of mother and infant displays such as looking, touching, vocalising, and smiling dynamically relate. An attempt has been made to code these features singly and then aggregate the results and look at sequences of combinations such as looking and vocalising (Gunn, Berry & Andrews, 1979). But do mothers (and infants) act in this way in vivo? Recent research in event perception suggests that people perceive a flowing, dynamically-changing stimulus array--not just a procession of static images shifting location in space and time (Johansson, von Hofsten & Jansson, 1980). Aspects of the dynamic display are assimilated to organising structures and assigned differential salience. Micro-analyses of event recordings of discrete behaviours or crude aggregates of behaviours cannot take sufficient account of the dynamic perceptual processes operating in vivo. In short, the models currently imposed on the data by micro-analytic researchers can be criticised on a number of important grounds.

In the haste to adopt and master a current style of micro-analytical model, the central role of the participants' perceptual and cognitive capacities has been overlooked (Parke, 1978). Most micro-analytic approaches have, in part, been fuelled by a reductionist desire to reduce interactional behaviour to its most elementary level, and understand more complex phenomena by "combining well-understood fundamental parts" (Morgan, 1977, p. 657). But in this process the meaning of the "parts" to the participants has been ignored.

Problems and prospects in studying constructions

Constructs operate as part of a theory. The theory may be primitive or naive (Baldwin, 1967; Heider, 1958); it merely serves to organise our systems of constructs. The study of the naive theory that a mother, for example, builds of her infant may provide an insight into the meanings she assigns to the infant's behaviours. Further it may provide a basis for determining the principles by which she perceptually organises and conceptually interprets that behaviour. As scientists we require what Schutz called "constructs of the second degree" (Magoon, 1977), by which he meant constructs about the constructs of the social actors we seek to describe. This is problematic. It is one thing to attempt to describe behaviour as an external observer and another to describe the way people think about their behaviour.

Focussing on the processes of event perception in mother-infant interaction may provide valuable clues to the features of the infant's repertoire that mothers construe as salient. Examination of the way persons perceive the stream of another's behaviour and organise it cognitively may provide a more efficient basis for understanding the temporal organisation of interaction than overlaying essentially ad hoc models on micro-analytic data. Again it should be recognised that the range of models that can be applied to such data is potentially infinite, limited only by the imagination of the researcher, the biases of the data collection technique and current conceptions of the phenomena being described.

A more productive direction for research may be in consideration of the match between mothers' subjective organisation of infant behaviour and the data generated by the researcher's analyses. Such a course seems to offer greater hope of bringing the salient features regulating interaction into sharper focus. Micro-analyses, as currently applied, would seem to involve a high probability that the salient features of the interaction will be swamped by the mass of marginally relevant, discrete behavioural events. Succinctly put, micro-analyses seem to offer considerable potential for burying the salient interactional signals in a cacophony of behavioural noise. In contrast, working back from the subjective data to the behavioural analysis may provide richer insights into the process of differential perception of the salient features in the highly diverse display of infant action.

The work of Newtson (1976) provides an interesting set of take-off points for such a research program. Newtson has extensively examined the way in which people unitise the ongoing behaviour of others. He regards the break points that individuals report in the stream of another's behaviour as high information points. Post hoc analyses of the behaviours surrounding the break points reported by individual mothers, may facilitate the identification of the salient features of the infant's behaviour to which the mother responds in interaction. As Lieberman (1979) has argued, the marriage of subjective methods and behavioural analyses may ultimately provide a better basis for understanding the organisation of behaviour. Further, such an approach should facilitate the enunciation of the links between molecular and molar levels or organisation.

Newtson has also provided data suggesting that the level of unitisation of ongoing behaviour varies systematically as a function of the predictability of the behavioural events used for unitisation. Variations in the unitisation of behaviour may prove to be useful indicators of developmental change at the level of the relationship. They may also provide inferential evidence of the conceptual frameworks within which mothers view their developing infant.

Newtson's work provides one example of how a new approach to the study of social behaviour may be possible, combining new concepts and methods, not abandoning close attention to the stream of behaviour, but adopting instead a new way of conceptualising and studying it. With such approaches, developmental psychologists may begin to address a number of questions concerning interaction that have long been overlooked. Questions such as "what are the psychologically meaningful units and categories for the participants in any interaction?", and, "how does the capacity to perceive and construct the stream of another's behaviour develop?" may at last begin to receive serious attention.

Note

An earlier version of this paper was presented to the International Conference on Infant Studies, New Haven, Connecticut, April 11 to 13, 1980.

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